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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVII.—No. 400.

THE JABLOCHKOFF BATTERY.

ALREADY comments, the nature of which can scarcely be misunderstood by the gentleman who issues invitations to notable personages to view the demonstrations made with M. Jablochkoff's latest *novelty*, have been published in our pages with a view to showing that this battery is no advance in electrical science. It may be that we have not yet said enough, therefore we will ask a few pertinent questions which M. Jablochkoff may or may not be able to satisfactorily answer. We will once more preface our observations by remarking that it is well known that almost any battery may be "regenerated" when exhausted by sending a current through it from another source; this result M. Jablochkoff claims to effect by constructing what may be termed a compound battery with three electrodes. Now, we would ask, even supposing the accumulating or self-charging action upon which the inventor prides himself, takes place to any extent, and assuming that the internal resistance of the cell may thus be diminished for a time owing to the larger surface of the electro-positive element exposed, viz., the hydrogenised carbon together with the zinc scraps, can the electromotive force obtained by this means exceed, or even equal, that produced by using the zinc directly opposed to the carbon tubes without the intervention of the carbon tray (the third electrode)?

Does M. Jablochkoff make use of any chemical agent to act as a depolariser for a time and to oxidise the hydrogen evolved during the action of the cell, and would not a cell of this type made up with carbons free from any adventitious oxidising agent, exhibit polarisation as in any ordinary form of single-fluid cell, although the recovery on resting would, in the suggested case, probably be quicker?

Is not this battery so inconstant that a cell placed in circuit with a galvanometer indicating an initial current of 0·33 ampère, will fall in 12 hours to 0·035 ampère, and that a rest of two hours will only allow the battery to recuperate itself sufficiently to rise to 0·042 ampère?

Is it not patent to every person conversant with the chemical actions which take place in batteries, that since a neutral solution of chloride of calcium is the liquid employed, and there being no free acid to combine with the zinc or iron, nor any salt with a readily decomposable base, there would be formed on the surfaces of the zinc a film of hydrated oxide or oxychloride which would lead to a serious increase of internal resistance?

Has not this battery the disadvantages of rapid polarisation on circuits of but a few ohms; great variability of internal resistance with alternations of pressure at the contacts when connected up in the manner proposed by the inventor; great difficulty in examining and removing any one in a pile; and, lastly, the necessity for frequent cleaning and renewal of the solution?

If M. Jablochkoff or his representative should think these questions worthy of a reply we shall offer them every facility to refute that which is here, and which has previously been, written by us respecting the value with which this invention should be credited.

THE CALORIMETRIC MEASUREMENT OF GLOW LAMPS.

By WILHELM PEUKERT.

AN important advantage of the electric light as compared with other systems of illumination, lies in the relatively far smaller amount of heat developed by the former for an equal intensity of light. Accurate calorimetric measurements of glow lamps have not yet been made public, and the results obtained with such lamps are therefore given below, whilst I reserve for a future occasion a report on corresponding experiments with arc lamps. The experiments may be of interest from another point of view, as they enable us to form a conclusion as to the economical utilisation of the electric energy consumed by a lamp. The working of a lamp, other circumstances being equal, must be considered the more rational the greater the proportion of the electric energy absorbed which re-appears in the amount of light generated.

The experiments have been conducted in the electrotechnical laboratory of the Technical High School at Hanover, and it is my pleasant duty to put on record my obligation to Prof. Dr. W. Kohlrausch, who placed at my disposal the necessary apparatus, as well as to Herren Caspari and Ottesen, who took part in the measurements.

The determination of the heat evolved by the glow lamps was effected by means of a calorimeter. This consisted of a large beaker of thin glass, which was filled each time with a quantity of water carefully weighed.

The glow lamp in question was immersed in the water, which was continually kept well mixed by means of a simple agitator, and possessed a uniform temperature. This temperature was observed on a thermometer placed in the calorimeter, graduated in tenths of a degree centigrade. The calorimeter was fixed on a heat insulator, and to avoid as far as possible losses of heat to the surrounding air, a very slight difference between the respective temperatures of the air and the water was maintained during the experiments, amounting to 5° C. in one case only, and being in others always below this maximum value. That, in fact, the increase in the temperature of the water was little affected by the temperature of the air, is shown by the following rises of temperature taken at equal intervals of time, which in few cases differ by 0·1° C. The temperature of the work room increased only by 1° C. during the entire time of the investigation.

To ascertain the absorption of light every lamp was determined photometrically, both when exposed freely and when placed in the calorimeter. As a standard of comparison, I used Von Hefner-Alteneck's normal flame. The current was furnished by a Schuckert's compound machine driven by a well-regulated Otto gas engine, so that the potential difference at the lamps, measured with a Siemens and Halske torsion-galvanometer, remained very constant. The strength of the current was determined with the same instrument by ascertaining the difference of potential at the ends of an accurately known resistance.

The results obtained are as follows :

Siemens and Halske Glow Lamp.

The lamp worked with a potential difference of 98 volts and a strength of current of 0·554 ampère, which values were found as the mean of all the observations executed simultaneously, which, as already mentioned, differed little from each other.

The calorimeter contained 2,471 grms. water, and if we calculate the value of the vessel in water as 79·1, the total quantity of water was 2,550·1 grms.

The observations were made at intervals of three minutes.

Thermometer.	Rise of temperature
14·9°	0·6°
15·5°	0·7°
16·2°	0·8°
17·0°	0·7°
17·7°	0·7°
18·4°	Mean 0·7°

This rise of temperature of 0·7° in three minutes gives an hourly development of heat of 35·7 kilogram calories.

The lamp when burning free gave a light of 8·8 normal candles, and when in the calorimeter, 8·1.

Edison's Glow Lamp.

Potential difference at the lamp = 93·6 volts; strength of current = 0·963 ampère.

Total quantity of water, 2,791·1 grms.

Observations at intervals of five minutes.

Thermometer.	Rise of temperature.
14·65°	1·65°
16· 8°	1· 7°
18· 0°	1· 6°
19· 6°	1· 7°
21· 3°	1· 6°
22· 9°	Mean 1·65°

The rise of temperature of 1·65° in five minutes gives an hourly development of heat of 55·26 kilogram calories.

The lamp, burning free, gave a light of 16·9 normal candles, and in the calorimeter 14·4 normal candles.

Swan's Glow Lamp.

Potential difference = 76 volts; current = 2·552 ampères. Quantity of water, 2435·1 grms. Observations every two minutes.

Thermometer.	Rise of temperature.
15·1°	1·7°
16·8°	1·7°
18·5°	1·7°
20·2°	1·7°
21·9°	1·7°
23·6°	Mean 1·7°

A rise of temperature of 1·7° in two minutes represents an hourly development of heat of 124·19 kilogram calories. The lamp, burning free, gave a light of 30 normal candles; in the calorimeter of 28·2 normal candles.

Bernstein's Glow Lamp.

Potential difference = 48 volts; current = 3·934 ampères. Total quantity of water, 2425·1 grms. The observations were made at intervals of two minutes.

Thermometer.	Rise of temperature.
15·5°	1·1°
16·6°	1·1°
17·7°	1·1°
18·8°	1·1°
19·9°	1·1°
21·0°	Mean 1·1°

The rise of temperature of 1·1° in two minutes gives an hourly development of heat of 80·03 kilogram calories.

The lamp, burning free, gave a light of 52·1 normal candles, and in the calorimeter 51 normal candles.

Concerning this lamp, it must be remarked that the quantity of heat as determined is possibly too low, since losses of heat were not absolutely excluded in the experiment owing to the construction of the lamp, which could not be entirely immersed in the water.

As the electric energy consumed by a glow lamp is converted into heat and light only, the portion of the total work of the current equivalent to the light evolved may be determined approximately, if not with absolute accuracy. An experiment may here be mentioned which was performed with an Edison A lamp.

It was placed in the calorimeter along with a vessel of thin sheet copper, so that light and heat were kept back. The amount of heat determined in this case agreed to 2 per cent. with that calculated from the potential difference and the strength of the current.

If we may assume that in the first-mentioned experiments the entire heat developed was absorbed by the calorimeter, and that the heat lost in the air was but small, which approximately speaking was the case, we obtain for the quantities of light evolved by the various lamps the following equivalent quantities of heat.

Siemens and Halske's Lamp.

	Kilog. calories.
Hourly quantity of heat corresponding to the work of the current...	46·98
Heat equivalent to the light evolved ...	11·28
Hourly heat per normal candle	1·393

Consequently for this lamp, with reference to the absorption of light, the heat evolved hourly may be estimated at 37·73 kilogram calories, corresponding to 74 per cent. of the total work of the current, so that 26 per cent of the current falls to the quantity of light evolved.

Edison's Lamp.

	Heat units.
Hourly amount of heat corresponding to the work of the current	78·01
Heat equivalent to light evolved	22·75
For normal candle hourly	1·58

Thus the heat evolved hourly by this lamp may be taken as 51·31 heat units. Hence 66 per cent. of the work of the current are expended in heat and 34 per cent. in light.

Swan's Lamp.

	Heat units.
Hourly amount of heat representing work of current	167·86
Heat equivalent to light evolved	43·67
Therefore for a normal candle hourly ...	1·549

The heat evolved by this lamp hourly is 121·4 heat units. Hence 72 per cent. are expended in heat and 28 per cent. in light.

Bernstein's Lamp.

	Heat units.
Hourly amount of heat representing work of current	163·43
Heat equivalent to light evolved	83·4
Therefore hourly per normal candle	1·635

The hourly heat for the lamp is therefore 78·24 heat units. Of the total work of the current, 48 per cent. is expended in heat and 52 in light. This high percentage may be due to the circumstance that, as already mentioned in the experiments with this lamp, considerable losses of heat were not excluded. Indeed, the percentages of the work of the current assigned here to the production of light can only be regarded as the superior limit. Experiments more precise than those here described may possibly yield lower values.

If the hourly quantities of heat per unit of light are calculated into their equivalents of mechanical work, we obtain the mechanical work per second equivalent to a unit of light (and therefore for a magnitude which may be regarded as the mechanical equivalent of this light), the following values: 0·16 kilogrammetres (Siemens and Halske), 0·18 (Edison), 0·18 (Swan), and 0·19 (Bernstein). These values show a sufficient agreement for the experiments just described, but can by no means be regarded as giving an accurate value for the mechanical equivalent of light. Indeed, the experiments were not conducted with any such intention. These results are merely mentioned here as a corollary of the experimental conclusions perhaps not quite devoid of interest.

For the sake of comparison, the amounts of heat obtained with other sources of light are tabulated along with those found with glow lamps. The hourly quantities of heat evolved are :—

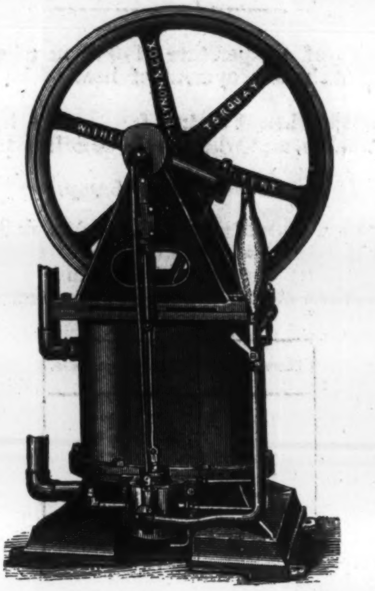
Glow lamps.	Siemens and Halske ...	427	heat units.
„ „	Edison	355	„ „
„ „	Swan	430	„ „
„ „	Bernstein	153	„ „
Gas.	Siemens's regenerative burner	1,500	„ „
„	Argand	4,860	„ „
„	Two-hole burner...	12,150	„ „
Petroleum.	Round burner	3,360	„ „
„	Small flat burner ...	7,200	„ „
Solar oil.	Schuster & Bauer's lamp ...	3,360	„ „
„ „	Small flat burner	7,200	„ „
Rape oil.	Carcel lamp	4,200	„ „
„ „	Reading lamp	6,800	„ „
Paraffin candles ...	... ...	9,200	„ „
Spermacetti candles	... ...	7,960	„ „
Wax candles ...	... ...	7,960	„ „
Stearine candles...	... ...	8,940	„ „
Tallow candles ...	... ...	9,700	„ „

The above-mentioned experiments have led me to undertake a close investigation into the conversion of electric energy into light and heat both in glow lamps and arc lamps. A memoir on this subject will shortly appear.—*Zeitschrift für Elektrotechnik.*

THE WITHERS PATENT GAS ENGINE.

THE annexed engraving shows a very simple construction of gas engine manufactured by Messrs. Beynon and Cox, of the Torbay Iron Works, Torquay, and exhibited by them at the International Inventions Exhibition. The engine, says the *Mechanical World*, is of the non-compression type, an explosion taking place once in every revolution. The explosive mixture is supplied and ignited, and the resulting products of the combustion of the mixture are exhausted by means of a single cylindrical valve. This valve is provided with a centre through-way port serving to connect, at the required time, a mixing chamber, on one side of the valve chest, with the cylinder port, and consequently the interior of the cylinder. It has also a large recess on one side of the central port serving to connect the cylinder port with an exhaust port when the products of combustion of the explosive mixture are to be exhausted. On the other side of the central port is a second through-way port in which is a gas jet supplied with gas from a small gas pipe by means of a cavity or passage in the valve chest, and a small port in the valve. The jet is ignited through the through-way port, from a stationary flame just outside the valve chest. In order to ensure a uniform supply of gas to the cylinder for each charge, a small stop valve is provided, worked from the end of the shaft which connects the gas main with the supply port in the valve. As the valve moves forward about one-half its stroke to admit the charge, the valve opens communication between the mixing chamber and the cylinder. The valve is operated by means of the connecting rod, as shown, and a roller forced to bear upon a cam on the main crank-shaft by means of a spring. The engine is fitted with a water jacket, preventing any possibility of overheating and the consequent wear and tear.

The operation of the engine is as follows :—Supposing the piston to be at the bottom of its stroke and that the space below it contains air, and that the gas bag is full of gas, the slide valve will be in such a position that its central port makes communication between the cylinder and the mixing chamber, so that the combustible mixture passes into the combustion chamber. The charge contrives to pass into this chamber during one-third of the up or working stroke, the valve remaining stationary during this period. The valve is then moved by the cam and the supply cut off, and communication opened between the cylinder port and an igniting jet in the slide which explodes the charge in the combustion chamber and drives the piston forward for the remaining two-thirds of its stroke. Just before the end of its working stroke, the piston uncovers an exhaust opening allowing of the free escape of the products of combustion. At the same time the slide valve admits air which thoroughly purges the cylinder. During the back stroke of the piston, the exhaust cavity of the valve makes communication with the cylinder port, and the remaining products of combustion are forced out.



In order to clear the igniting nipple in the valve of the products of combustion after the explosion, it is put in communication, by a port in the valve, just before it reaches the end of its stroke after the explosion, with an exhaust port effectually relieving the pressure in the gas port of the valve, and ensuring that the nipple shall be charged with gas in time for the next working stroke. The jet is relighted on the return stroke of the valve by the fixed jet, it being kept supplied with gas through a passage in the valve. It will also be seen that during the whole time the piston is descending, the igniting jet is opposite the stationary flame. The engine, as stated above, is simple; it is controlled by a single slide valve without any gearing, and can readily be taken to pieces, cleaned and put together again by any ordinary person, which is a great desideratum where the engine is worked by inexperienced hands. The engine is fitted with a governor and also with a water jacket, so as to prevent any possibility of overheating and the consequent wear and tear. During the Building Trades' and Manufacturers' Exhibitions held at Bristol, it was employed, we are told, by Messrs. King and Co. to drive a small dynamo-electric machine, feeding Swan incandescent lamps, lighting up their exhibits, and was stated by them to be remarkably constant in speed, and gave them perfect satisfaction in every way.

BAZIN'S ROTATIVE BATTERY.

THIS battery, we understand, has been designed for the purposes of electric lighting, and the representatives in London are MM. Huon & Collet.

M. Bazin's apparatus is a combination of Poggendorff's bichromate battery, and of mechanical depolarisation by rotation, the principle of which is therefore very old.

Fig. 1 shows the arrangement adopted.

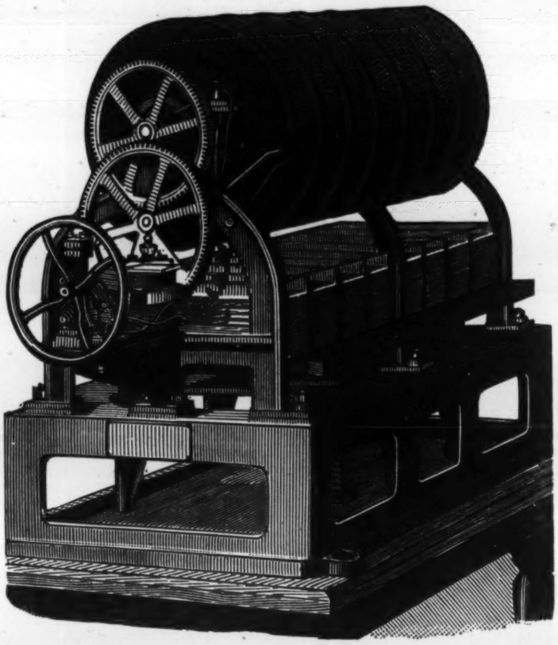


FIG. 1.

The zincs and the carbons are mounted upon one and the same axle, to which a slow and regular rotatory movement is communicated by the aid of a small electric motor supplied by a distinct element. The battery represented in fig. 1 comprises eight elements, seven of which are utilised in the outer circuit; each element is composed of a disc of zinc placed between two discs of carbon; the liquid is contained in rectangular troughs, which hold each 3 litres. The immersion of the elements is regulated by raising up a platform on which all the troughs are placed. The immersion may vary from zero to one-third of the surface of the discs, according to the degree of exhaustion of the liquids.

The diameter of the discs, and the number of the elements in series, may be made to vary according to the duration of the effects to be produced in the outer circuit. M. Bazin has constructed other models with oscillating elements, but we (M. Hospitalier in *L'Electricien*) have not had the opportunity of experimenting with them. In all the movement is communicated at once to the carbons and the zincs, which in our opinion is an inconvenience, since the liquid conveyed out of the element by the zinc during rotation is used in pure loss.

However it may be, here are without comments the results obtained in the best of the three complete discharges which we have had the opportunity of effecting with the rotative battery.

The battery used in the experiments comprised eight elements; one of these elements served to supply the motor which gives the axle supporting the zincs and the carbons a rotation of about one revolution per minute; the other seven elements are connected in series on the outer circuit. This outer circuit is composed, beside the connecting wires, of a resistance of 0·1 ohm in nickel silver, 6 millimetres in diameter, four Cruto lamps of 6 volts, arranged in parallel, and an ampèremeter.

The current was measured by taking the differences of potential at the extremities of the resistance of 0·1 ohm with a movable frame galvanometer (Deprez-d'Arsonval's model) previously calibrated by a total resistance of 2,000 ohms, and giving under these conditions 50 divisions per volt on each side of the scale. The sum of the two readings gave the current directly in tenths of an ampère.

The same apparatus enabled us to measure the differences of available potential at the extremities of the battery, by raising the total resistance of the circuit of the galvanometer to 10,000 ohms.

The arithmetical mean of the two readings of each side of the scale gave this difference in tenths of a volt.

The corresponding available power in watts was obtained by multiplying the current by the difference of potential.

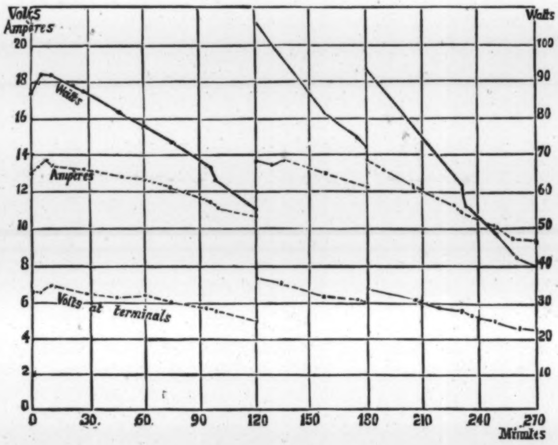


FIG. 2.—DIAGRAM OF THE DISCHARGE.

The total quantity of electricity supplied, as well as the total electric energy, were obtained by measuring the corresponding surfaces of the subjoined diagram (fig. 2) by means of Amsler's planimeter.

Each of the elements contained 3 litres of liquid. This liquid was an acidulated solution of bichromate of potash; 125 grammes bichromate, and 300 grammes sulphuric acid per litre.

The discharge was effected in three stages :—

1. Continuous discharge for two hours (from 0 to 120 minutes). Stoppage of two hours twenty minutes.
2. Continuous discharge for one hour, with a greater immersion of the elements (from 120 to 180 minutes.)
3. Total immersion of the elements and continuous discharge for 90 minutes, without stoppage between the second and the third stage.

The elbows of the curves at the points 120 and 180 minutes indicate distinctly the augmentations obtained in the yield by the decrease of the internal resistance resulting from the increase of surfaces.

The subjoined table summarises the principal conditions of the total discharge, the factors of which are shown at each instant by the diagram, fig. 2.

Duration of discharge	4½ hours.
Quantity of electricity supplied ...	198,000 coulombs.
„ „ „	55 ampère hours.
Total available work	0·45 H.P. hour.
Total consumption of zinc (motor not included)	1126 grms.
Mean consumption of zinc per element	160·9 „
Effective consumption per ampère hour	2·93 „
Theoretic consumption	1·213 „
Ratio of the two consumptions ...	2·4 „
Mean power of battery during a discharge	75 watts.
Mean power of an element	10·74 „
Maximum power of an element ...	15· „
Initial electromotive power (7 elements in series)	13·1 volts.
Final do. do.	11·9 „

If we calculate the consumption of the battery as referred to horse-power hours, and taking account of the circumstance that the seven elements during this discharge have yielded 0·45 horse-power hour, we find in round numbers :—

Zinc	2½ kilos.
Bichromate of potash	5½ „
Sulphuric acid	13 „
Total volume of solution	45 litres.

Such are the present working conditions of the Bazin battery. To justify the insufficiency of these results, M. Bazin points out that our experiments have been made with the first apparatus constructed for his own studies, and necessarily incomplete. He promises by October next more perfect apparatus, in which we shall find decided improvements. We shall therefore await further experiments before passing a final judgment.

THE DAFT ELECTRIC RAILWAY AT BALTIMORE.

A WRITER in the New York *Electrical World* gives the following particulars respecting the adaptation of electricity for propelling tramcars on a two-mile length of line in Baltimore. We shall be pleased to record the results of this trial from time to time, and we trust that the experiment may be of such a nature as to lead to the permanent adoption of electrically driven cars over the whole line. Our informant writes :—

In the early part of last spring the Baltimore Union Passenger Railway Company, hearing of the rapid progress of the Daft Electric Light Company with their system of electric railroad lighting, and wishing to increase their carrying capacity, investigated the matter. Satisfied with the completeness of the system, an order was at once given to construct two motors and equip the Hampden branch of their lines.

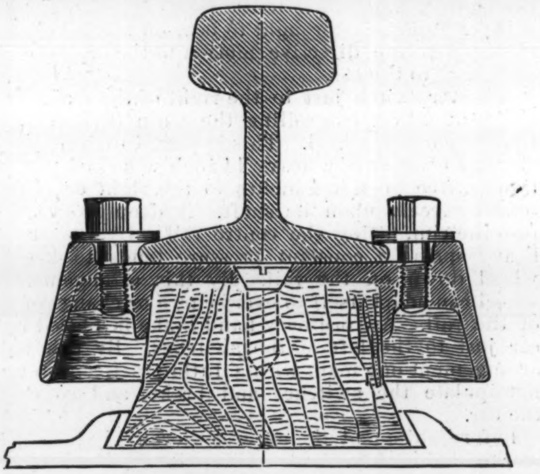
It was some time, however, before definite plans were settled upon ; but about the middle of last April work was commenced both at Baltimore and at the Daft works. On June 10th the first motor was shipped, after having undergone a week's severe testing. The Baltimore Union Passenger Railway Company is one of the largest in the city. It operates twenty-five miles of roads, and has within its stables nearly 400 horses. The Hampden branch is just two miles long, runs through the villages of Hampden, Mt. Vernon and Woodbury, aggregating some 15,000 inhabitants, and is one of the hardest bits of line the company operates. Starting from the main terminus on Huntingdon avenue, there is scarcely 300 feet of level road throughout the entire length. The village of Woodbury, though not two miles distant, is 150 feet higher than Baltimore. Gradients and curves constitute the main features. The heaviest gradient on a tangent is 319 feet, and on a curve 352 feet per mile. The sharpest curve has a radius of but 50 feet, the largest 89 feet.

To equip this road the joints of the outer rails were perfected, and a third rail, an ordinary 25-lb T rail similar to the outer rails, laid, with the Daft patent insulator, midway between the outer rails.

The insulator (see fig.) consists of an iron shoe of diamond shape, 8 inches long, 3½ inches wide and ¼ inch thick, with two converging ways upon one of its surfaces.

Wedged between these ways is a round block of wood of truncated cone shape, in height, 2½ inches. Upon this block is screwed a round iron cap. This is 4½ inches in diameter and 2 inches deep. Coming within ¾ of an inch of the iron shoe, it thoroughly protects the wood block. The rail placed on the cap is held in position by two bolts screwed into the cap. The difficulties of constructing such a work, it being all entirely new, have been many, but have been met and successfully overcome.

The centre rail forms the outgoing lead, the two outer rails with the ground being the return. The resistance of such a line will be less than 0·3 of an ohm,* with perfect joints. At the main terminus a new building, forming one room 20 × 40 feet, has been built for the engine and dynamo. The engine is a 16 × 24-inch Atlas engine, built at Indianapolis. The boiler and all fittings are from the same firm.



METHOD OF RAIL INSULATION.

The dynamo is one of the Daft Company's largest. Its total weight is 4,200 lbs., and its maximum capacity is 300 ampères at 125 volts electromotive force. A 9-inch double belt connects direct from the 10-foot fly-wheel on the engine to a 15-inch pulley on the dynamo. Switches, regulators, automatic cut-outs and all other safety devices necessary for a complete system will be put in, as precautionary measures against every possible form of danger or trouble.

The receiving machine is a compound series motor capable of delivering 8 H.P. Its total weight is 1,100 lbs., the armature being 196 lbs. The compound nature of the field permits of a wide range of resistances, and hence of magnetic strength of field. As the armature speed depends, in a certain sense, upon this field, a perfect means of regulation of speed is obtainable.

Motion from armature shaft to car wheels is obtained by internal gears. Upon each end of this shaft a 3-inch phosphor bronze gear is keyed.

These engage with large gears, 27 inches in diameter, fastened to the axle of the driving wheels. By this arrangement the energy of the armature is utilised practically almost directly upon the periphery of the driving wheels. The speed of armature to drivers is as 9 to 1. Therefore as the wheels must make 509 revolutions to the mile, the armature makes 4,581 revolutions.

The ratio of peripheral speeds, however, of armature to drivers is as 3·27 to 1.

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* Should not this be per mile?—EDS. ELEC. REV

As high speed is the normal condition of an armature, no real sacrifice is made to gain leverage. The speed of armature for 8 miles an hour, the limit the law allows, is 610. To take up all back-lash of gears, the motor is arranged with pivotting bearings at one end and a regulating screw at the other, both resting upon heavy pieces of rubber. This pivotting arrangement is again advantageous in case of repairs, or inspection through accident; the large gears being held in place by means of a set screw and long spline. On loosening the set screw, they can be easily removed along on the axle, freeing the small gears. The motor then can easily be raised to a vertical position allowing free inspection.

The controlling device consists of four heavy brushes bearing upon a stout frame of soapstone carrying broad and properly shaped contact pieces. This whole is inclosed in an 8 inch by 16 inch iron box, with an ordinary engineer's handle and guide.

Four movements are made, controlling the combinations of the field magnets, which vary from 0·39 to 3·75 ohms. The resistance of armature is 0·24 of an ohm. By proper connections with the switch, the motor can be slowly and easily started, stopped or run. By turning a small handle placed just to the left of the main switch, either to the right or left, one of two pairs of brushes is brought to bear on the commutator, thus giving the directive motion to the armature, and obviously to the car.

Another switch just to the right of the main switch is a dead cut-off controlling the main current coming from a contact wheel. This is placed underneath the car, and consists of a heavy 14-inch wheel of phosphor bronze, free to slide 4 inches to the right or left, and rotating freely upon its shaft. A deep groove is cut into the rim, fitting the centre rail. By a lever and a heavy spring a constant pressure tends to keep the wheel down on the rail. By this arrangement the wheel can adapt itself to every curve or change of level of the rail. An ordinary hand brake is placed in the car just to the left of the switches. By this handy arrangement one man, with a little practice, can easily manipulate the switches and brake, and so control the car.

Before shipment the car was thoroughly tested, and worked admirably.

At Baltimore a few preliminary tests have been made over the entire length of the line. Although all arrangements have not as yet been completed, most excellent results have been obtained, ensuring its perfect success. At present, 60 round trips are made per day, each occupying 45 minutes; and 29 horses are necessary to operate the line. On many of the grades and curves the two horses are taxed to their utmost. With proper joints bringing the resistance down to 50 per cent. above the theoretical, making the total resistance about 0·5 of an ohm, the motor is estimated to haul two cars over all the curves and grades, and make a saving of nearly 50 per cent. in time.

THE ELECTRIC ARC LAMP FRICTIONAL CLUTCH.*

By EDWARD P. THOMPSON, M.E.

THE well-known trick of a ball and string passing through a crooked hole in the ball, whereby the loosening and tightening of the string cause the ball to fall and to stop respectively, operates upon the same principle as the frictional clutch, and the principle may therefore be defined as a clutch for a carbon holder, consisting of a device whereby a variation of pressure upon the carbon holder produces a variation of motion of the electrode. Any device falling under this definition is a frictional clutch.

Any one making a frictional clutch will infringe no one's patent so long as he makes a clutch different from any other clutch in every detail; for the patent granted to Slater & Watson, of London, in 1852, No. 212 (English), includes two superposed clutches which are simultaneously the armatures of electro-magnets, and through both of which the carbon holder freely falls when the armatures are horizontal, but ceases to move when the armatures are inclined, exactly in the manner of action of the ring clutch in the Brush lamp.

Some have said that the unsteadiness of the arc lamp is due to the poor quality of the carbon; others, to the defects in the generator; others, to the cutting in and out of other arc lamps; others, to poor construction of the system in general; and others, to all these combined; while they seem to think that the clutch has reached its perfection and there is nothing to be said against it; whereas, according to the definition, a clutch could certainly be made which would produce alternate darkness and brightness at almost any rate.

We may safely say that the steadiness depends upon the clutch more than upon anything else.

Coming now to the action of the ring clutch and all its modified forms and adjuncts, let its operation be analysed thus, with as little reference as possible to any other part of the lamp. When the ring is horizontal, the carrier of the carbon electrode is free to fall. When it is inclined at its maximum, the carrier is retained in a fixed position. At a certain point of inclination, the least increase or decrease of inclination will cause the carrier to fall or to be retained from falling. If the increment or decrement of inclination be infinitesimal, the carrier and clutch are still in contact, and the friction existing between the two surfaces diminishes the velocity as it tends to increase, and thereby gives the holder a uniform motion through an infinitesimal distance; but the increments and decrements of inclination of the ring are not infinitesimal, and therefore the ring and carrier are not in contact when the decrements of inclination occur, although the period of non-contact is very short. The consequence is that the velocity of the carrier increases as the square of the distance during the time that the ring and carrier are out of contact. To take the place of this lack of the retarding effect of friction, inventors have supplied a dash-pot whose piston is connected directly or indirectly with the ring. This is a help, undoubtedly, and its efficiency would be very marked were the individual movements of the carriers of any considerable degree; but as they are all within a distance of a very small fraction of an inch, such as a tenth or a hundredth, the piston scarcely acquires any motion at all, and especially not till after the carrier has been checked by an increment of inclination of the ring, on account of the inertia of the parts and lack of definite motion at the connecting joints.

As a means of closing doors noiselessly and in steam engines, the dash-pot is very desirable and effective for the purpose intended, and is adapted in all cases where any considerable extent of motion takes place; but for an arc lamp clutch it is theoretically and practically a non-success.

Several patents have also been taken out involving a spring attached to the ring, so that the motion of the carrier will be retarded when the ring is inclined. This may be called an improvement from some stand points, but the fact still remains that the carrier and ring, even with the spring attachment, do not remain in contact, and therefore the movements of the latter, being vibratory, the movements of the former are vibratory also, and not only vibratory, but jerky, as familiar to all versed in the art.

Waterhouse and Loomis have introduced further improvements by having two ring clutches, the former inventor supplying dash pots and springs and locating the two rings at a distance from each other; while Loomis's patent locates the one ring upon the other with a spring between the two, the idea in each being to obtain steadier motion by such an arrangement that the primary clutch is assisted by a secondary clutch, producing a combined and more effective result.

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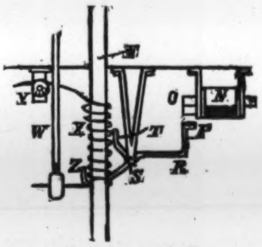
* Abstract of a paper read before the American Institute of Electrical Engineers, May 20th, 1885.

However, in all the improved forms thus far mentioned, and in numerous other patents acting on the principle of the ring clutch, the motion of the latter is abruptly intermittent, and therefore that of the carrier is abruptly intermittent also. A clutch to be perfect, practically and theoretically, should operate to produce a continuous increase or decrease of pressure upon the carrier, and the piece producing this pressure should always be in contact with the carrier ; *i.e.*, the pressure should never be zero, neither should it be so far diminished for maximum movements of the ring that the carrier has an accelerating motion.



New Arc Lamp Clutch.

We have before us a clutch invented by Mr. Jean A. Wetmore. It combines within itself all the qualities and fulfils all the conditions required.

Its true value will be appreciated upon inspection of its construction and operation. As seen, it consists of a cylindrical coil spring through which passes the carbon carrier. By certain manipulations of the spring, the carrier may be regulated in its movements with the utmost nicety. If the spring is bent laterally, the carrier is lifted. If the spring is partially straightened again, the carrier is subjected to less pressure, and consequently its own weight causes it to move downward, not with an accelerated, but uniform motion, because the coil spring, tending to straighten itself, constantly presses against the carrier. It may be manipulated by the hand as easily as a ring clutch by electro-magnets, showing that its good results are not dependent upon the delicacy of action of the operating force. Accordingly, when operated by electro-magnets in the main and shunt circuits, the carrier is regulated so perfectly that the light is almost as steady as that of an incandescent lamp.

This clutch may truly be said to act by causing a variation of pressure upon the carrier. It may be operated effectually by the separate action of the shunt and main magnets, or by that of both, as in most ring-clutch lamps. The application of both magnets to its action is as simple as in the coil spring itself, and is accomplished by arranging the main magnet to *bend* the coil by a lateral pull upon its lower end, and the shunt magnet to straighten the coil by means of a forked lever, each end of which acts upon the opposite ends of the coil spring respectively and in opposite directions. There are several modifications adapted to be applied to cause the clutch to act, and the general mechanism may be the same as or different from that of any other lamp. Mr. Wetmore has shown as much genius and simplicity in the details of construction of the whole lamp as in that of the clutch itself.

When the main and shunt magnets are both employed to operate the clutch, the arrangement of the levers is as shown in the drawing.

F shows the carbon holder, and the helical line shows the clutch, while the main magnet operates the end of the coil, and while the other end is fixed to the support, Y. The shunt magnet operates the lever, R, which is forked by the branches, T and Z, the two arms being adapted to straighten the spring, while the main magnet is adapted to bend the spring and thereby retain or lift the carbon holder according to the amount of movement upward of the lower end of the coil spring.

DISCUSSION.

Mr. Thompson: Thirty years ago Lacassagne and Thiers invented the differential magnet applied to the arc lamp, and it is the preferable form to apply with any clutch. The main magnet is modelled to bend the spring laterally. The shunt magnet acts on opposite ends to straighten the spring. There is no great movement necessary; it will take place even in a smaller distance than with the ring clutch.

Mr. E. P. Roberts: I understand Mr. Thompson to claim that the motion is so uniform that it does away with all necessity for a dash pot. If that is correct, I should say it would be most valuable in many places. I have had experience with dash pots freezing up.

Prof. W. A. Anthony: I have been very much interested in this paper, and the device seems to me very ingenious and very useful. I rose merely to speak of what I conceived to be the theory of the action of the thing. I understand from Mr. Thompson that his idea of the action of friction is that it does not depend on the velocity except in some cases; but I have found by actual experiment that in all cases of very slow motion the friction does depend upon the velocity, and that it increases with the velocity in the case of iron upon iron, and wood upon iron, and brass upon brass. After the velocity reaches a certain—not a very large—amount, a velocity of a foot a second or something like that, then the friction becomes very nearly uniform and even diminishes somewhat, but at first the friction does increase and increases considerably with the velocity. Now it seems to me that that explains very well the whole action. The pressure of the spring upon the carbon rod is a very light one, and it varies only through small amounts by a considerable motion of the magnet, as I conceive it. Now, if the pressure is diminished somewhat, the rod will go faster and so increase the friction by an increase of velocity; and if the friction is equal to the weight of the rod, then the rod will move with a uniform velocity. It is perfectly well known everywhere that when the forces acting on a moving body balance each other, the motion is uniform. Now, if an increase of velocity increases the holding force, and makes it equal to the weight of the rod, the rod will move with a uniform velocity, and that up to any velocity that would ever be allowed in the case of a moving carbon holder; so that it seems to me that that does fully explain the action.

The Chairman: I understand that Mr. Wetmore, the inventor of this means of adjusting the holder of this carbon, is present, and as it does not require a formal motion, unless there is an objection on the part of the members of the society, I shall call upon Mr. Wetmore. He probably has gone through all the theories and views and studies relating to this method of adjusting the holder of carbon, and I ask him to give the society his ideas and his experience on the subject.

Mr. Wetmore: I have had some little experience in running different forms of electric lamps, arc lamps more especially, and they are continually getting out of adjustment and giving trouble. Another thing is that they are too complicated in a certain respect. A great many of those lamps have to be put into the hands of inexperienced men, men who are not well informed as regards the principles of electric lighting, and I made up my mind that it was almost a necessity to get the lamp as simple as possible, to make the parts perform as many offices as possible, and require as little adjustment as possible. Now this method of using a spiral spring for the clutch is the one I employ. This spiral spring not only has a clutch, but I may add it forms an electric contact between the incoming wire and the carbon holder. Of course this spring is always in contact with the carbon holder and the current is not interrupted, so that I make the spiral spring perform the action of a clutch, of a dash pot, and of an electric contact with the carbon holder. It is very easy of adjustment and requires very little attention. I do not know, gentlemen, that I have anything further to say in regard to the matter.

Mr. Roberts: I would like to ask Mr. Wetmore whether in running his lamps he finds any burning on his rod, and whether he uses any other contact besides his spiral spring?

Mr. Wetmore: When I first started to experiment with it I found that there was a tendency to heat, but no burning; that was when I employed a very light spring; but you will see that the spring I have here is of quite heavy diameter, and I found that in employing that and adding the weight of the carbon to the weight of the carbon holder, it gave me a perfect electrical contact between the spring and the carbon holder, and I found no difficulty whatever in respect to burning. There were three principal points of contact in that spring with the carbon holder, and each principal point of contact is composed of several points of contact. If you will allow me I will explain that. The spring in its normal condition is perfectly straight. I pinch it in that condition and you see it is perfectly solid (illustrating). Now what is the condition? There are three points of contact there. That is one principal point. Here, commencing on this side, there are several—eight, or ten, or fifteen. There is another principal point of contact composed of several contacts, as you see. On this side again there are one or two. Now again I employ the shunt circuit to release these coils, and in what way?—The main circuit may be in operation and clutch it tightly. Now if there is more current going through the shunt circuit, I employ that shunt circuit and press in on the two sides. The result is that the spring is straightened and the carbon falls down slightly. All that is necessary is to have two forked pieces right there to press in on that spot.

Mr. Frankland Jannus: I would like to ask Mr. Wetmore one question: Whether there is enough difference in resistance between the clutch and the carbon rod at the period of feeding to affect the light? When it lets go, when the rod moves, and, of course, the contact is very materially lessened, does the difference in resistance then affect the light? Is there enough difference in the resistance to affect the light?

Mr. **WETMORE**: That is so far as interrupting the current?

Mr. **JANNUS**: Yes.

Mr. **WETMORE**: No, sir; there is not. That spiral spring is always in electrical contact with the carbon holder at all times.

Mr. **JANNUS**: I appreciate that point; but when it feeds of course it is in a position of holding together. When feeding takes place there is just as little contact as there can possibly be. Now at that time, I want to know, is there a sufficient difference in contact from what there is when the carbon holder is stationary, so as to make any difference in the light?

Mr. **WETMORE**: There is always frictional contact with this clutch, and that differs radically from the contact of a common clutch; that lets down suddenly, allows it to drop down quickly. With this it is constant and gradual, it is an easy sliding down.

Mr. **GEORGE A. HAMILTON**: I presume the resistance is so small compared with the resistance of the arc itself that it makes very little difference.

Mr. H. B. **SLATER**: If I understand the question of Mr. Jannus, it presupposes the case of an irregular motion when this spring feeds, or allows the carbon to feed; hence, that there is a variation in the pressure of contact, and consequently a variation of resistance. As I understand the explanation of the inventor, there is a constant and regular motion, and therefore a constant and regular pressure there. Thus there would be no variation in the resistance.

Mr. F. L. **POPE**: I think that the fact that there is no perceptible burning at the point of contact shows very conclusively that there is no resistance there. The production of resistance at the point of contact of the spring with the carbon holder, if it produced heat, would be just so much heat subtracted from the heat in the arc, and would produce a variation, but we find as a matter of fact, as the gentleman said, that no injurious heating is shown there. It is very evident that there can be no injurious resistance there.

Mr. **THOMPSON**: The weight of the carbon holder and the carbon is considerable. In order to retain that in a permanent position it requires a force equal to the weight. That force is the pressure with which the two are in contact, and of course there is no sparking or burning.

Prof. **ANTHONY**: In connection with just this point, I want to say that we have a carbon holder, a carbon rod of so much weight as there is in connection with an electric lamp, which is held so that it moves steadily with a slow motion. There must be sufficient pressure on that to carry the electric circuit without any appreciable resistance. Now if there is here a sliding, and not an actual letting go and allowing it to drop, such a slow motion necessitates a constant uniform pressure on the rod, which is sufficient to reduce the resistance to something very little—almost nothing in comparison with the arc.

THE BRIGHTON ELECTRIC RAILWAY.

A LONG discussion on this subject took place at a meeting of the Brighton Town Council, on Thursday week; the Works Committee, pursuant to a resolution of the Council of the 21st ult., requesting them to consider and report whether it was advisable that Mr. Volk's electric railway should be allowed to remain on the Beach, reported that they were of opinion that the electric railway is an attraction and an amusement to visitors to the borough, and that the Town Council should permit the same to remain for the present, pending the consideration of the question of improving Madeira Road, and the building of a lift or lifts therefrom to the Marine Parade, subject to the same terms and conditions upon which the railway is now permitted. The committee were also of opinion that Mr. Volk should pay an increased rental of £70 per annum for the arch opposite Paston Place, Groyne, now let to him at £20 per annum, and that such increased rental should commence from the 24th June last.

Councillor **BERRY** moved the adoption of the report, and pointed out that if at any time the development of Madeira Road were contemplated Mr. Volk would be subject to the same notice under the arrangement suggested by the committee as under that hitherto existing.

Councillor **WOOD** seconded the adoption of the report, and an amendment was moved by Councillor **HALL**, for the purpose of raising a discussion, to the effect that the rental for the arch and the privilege of running the railway should be fixed at £100 per annum. The railway had been recently assessed at £392 per annum, and deducting £20 per cent. for repairs, &c., the rateable value was £314. He challenged the committee to show on what intelligent basis they had come to the conclusion that £70 was a fair rental to pay.

Councillor **HUMPHREYS**, in seconding the amendment, said that the rental ought to be £250 a year.

Alderman **LAMB**, having professionally attended twice at the Assessment Committee when the assessment of the railway was under consideration, said that the gross receipts of the railway during the previous twelve months, as furnished by him to the committee, were £1,800, from which had to be deducted the working expenses, amounting to £1,200, leaving £540. Having these figures before them the Assessment Committee very soon considered what ratable value Mr. Volk ought to pay. It was a mistake to suppose that Mr. Volk had made a lot of money by the railway, and he might mention that during the last six months the receipts had only amounted to £200.

Councillor **WELLS** remarked that he looked upon Mr. Volk as one who wanted to attain wealth at the expense of the ratepayers. Mr. Volk was going to take all the profit, and he ought to pay for it.

Councillor **WESTON** said that he knew that the money for the railway had been found by some of the members of the Council, who supported the recommendations of the committee, a remark which he subsequently withdrew at the request of the Mayor.

The amendment was put, and lost by 10 to 29.

Councillor **BALLARD** moved, and Councillor **CARPENTER** seconded a further amendment that the report should be referred back to the committee, which was lost by 13 to 25.

Councillor **WELLS**, amid some laughter, moved an amendment to the effect that the rent for the arch and the site of the railway should be at least £400 per annum, but on this being put only three voted in its favour.

The original resolution was then carried by 28 to 11.

IMPORTANT TELEPHONE PATENT CASE.

(*Continued from page* 56.)

(*Specially reported for the* ELECTRICAL REVIEW.)

HIGH COURT OF JUSTICE.—CHANCERY DIVISION.

(*Before* MR. JUSTICE NORTH.)

UNITED TELEPHONE COMPANY, LIMITED, V. BASSANO AND SLATER.

Thursday July 16th, 1885.

PROFESSOR GEORGE FORBES was called and examined by Mr. **PLUMPTRE**. After the usual statements as to acquaintance with telephony, the specification of Edison, and the instrument of the defendants,

Mr. **PLUMPTRE**: First of all, as regards the diaphragm. What do you understand by the word diaphragm, used in its ordinary sense?—That is a question which I do not know that I am particularly capable of answering, except from the fact that in one's laboratory, and in physical science generally, one is continually using pieces of apparatus in which a diaphragm is used. Of course, if one goes to the derivation of the word, it means——

Mr. **JUSTICE NORTH**: Yes; but the ordinary usage of it?—Well, my own impression of the usage of it is, a thin flat partition dividing a piece of apparatus into two parts, or separating one part of an apparatus—one part of a structure, perhaps, would be better; that would include the human frame—dividing one part of a structure from another part. I do not know that I remember any case where the word in its ordinary acceptation, at the date of this specification, was ever given to anything that would not be included in that definition.

Well, now as to its use in telephony. Has it any particular meaning in telephony?—Do you mean now, or at the date of the specification?

Mr. **JUSTICE NORTH**: If there is any difference, tell me of which you are going to speak.—If I speak of the present date, I must say that in the course of the last few days I have learnt for the first time that it has a very different signification in some people's minds to what I ever knew of it before. If we speak of the date of the patent, I think the word in a telephonic sense may possibly have had some signification. Up to that time the only telephones that were practically known, or at least known to me, were Reis's transmitters.

Mr. **JUSTICE NORTH**: At the date of the patent, had the word any use that you know of other than its ordinary sense?—No different meaning.

The **ATTORNEY-GENERAL**: I am not going to contend that it has. "Telephonic sense" are Mr. Bigham's words, and not Sir Frederick Bramwell's.

Mr. **PLUMPTRE**: Now, as regards the word diaphragm, as used by Edison?—In the Edison specification, it seems to me that the sense in which he uses the word diaphragm is very clear; and he makes it still more clear by referring——

Mr. **JUSTICE NORTH**: Let me have, first of all, what it means in that specification.—The word diaphragm in this specification seems to me to retain the same signification which I have already given to it. The part of the apparatus which forms the diaphragm is very clearly described in the specification by describing it as "a diaphragm or tympan." This qualifies the meaning of the word; or rather, I should say, it adds to it, because a tympan is something in the nature of a drum-head, and the centre of a tympan is capable of resounding to the voice, and executing a to-and-fro motion in a direction perpendicular to its plane. These functions had been necessary in the diaphragm, if it was so called, in Bell's instrument, and they are essential features in the transmitter which is described by Mr. Edison.

Mr. **PLUMPTRE**: Will you be good enough to tell me, taking that construction of the word diaphragm, where you find it in that transmitter (handing up a model of an Edison instrument)?—The diaphragm here is a brass plate at the base of the mouth-piece.

As regards the position of that diaphragm, do you gather from the specification that it had any particular position in respect to the tension regulator?—Most distinctly so. That tympanic action or to-and-fro motion of the diaphragm centre is essentially necessary with respect to its relative position compared with the tension regulator. This to-and-fro motion has reference to the tension regulator, and so the position of the diaphragm has essential reference to the tension regulator. This is very clearly pointed out in this specification—the necessity for this.

Mr. Justice North: First tell me what you say the position so defined is?—The position is between the resonant chamber, as it is called, and the tension regulator. Its position with respect to the tension regulator has attention drawn to it very clearly.

First tell me what you say the position is?—Between the resonant chamber and the tension regulator, in all cases.

What is your proposition as to the position of the tension regulator with regard to it?—In the first place, that the diaphragm lies between the resonant chamber and the tension regulator, and in the second place, that the tension regulator is moved by the to and fro motion of the centre of the diaphragm.

I don't think anyone will dispute that. But is there any indication on which side of the diaphragm it is to be?—No, I think not.

Then the tension regulator is to be near the diaphragm?—If your lordship will refer to page 5, and the end of the fourth paragraph, you will read, "There being a delicate cork centrepiece, w, to the diaphragm, B, with a piece of platina foil."

What do you say about the position of the tension regulator?—That clearly indicates, to my mind, that the tension regulator must be in contact with the centre of the diaphragm, or in contact with something attached to the centre of the diaphragm, directly or indirectly.

Then you say also that there is nothing to indicate on which side of the diaphragm?—I really do not like to say for certain. It is my impression there is nothing. I find one case, fig. 10, in which the tension regulator is between the mouth and the diaphragm, and again, a second tension regulator in its usual place.

That is the tension regulator at both sides?—Yes; that is for a very special purpose.

Mr. Plumptre: Do you find any instance there where the tension regulator is in front of the diaphragm, except in fig. 10?—I am pretty sure I have not seen one. But I will first refresh my memory by looking again. I can confidently say I have not seen one.

Mr. Justice North: You don't find any instance where the tension regulator is wholly between the speaker and the diaphragm?—I do not; not a single instance.

Mr. Plumptre: Do you find explained in the letterpress description of fig. 10 the reason or object of having what I may call a double tension regulator, one on each side?—It has a rather peculiar action, that double tension regulator. In all other cases described in this specification, Mr. Edison depended on a variation of the strength of the current always in the same direction. In this case he depends upon being able to reverse the direction of the current, according as the diaphragm is moving forwards or backwards. Each tension regulator is connected with a separate battery, one being connected with the copper of the battery, the other with the zinc of the other battery. The copper tends to send what we call a positive current through the line, the zinc sends a negative current. When the tympan or diaphragm is in its ordinary position these neutralise each other.

Do those two touch it when it is in its ordinary position?—I understand it to be so. But if the compression of the tension regulator is greater on the one side than on the other, that kind of electricity will pass along the line. Thus, when the centre of the tympan is moving the forward way from the speaker, there will be a negative current through the line, when flowing towards the speaker the current is of course positive.

Mr. Justice North: Further off than zero would it not be negative in either case?—No; when it is further away from the normal position, the left hand tension regulator is most compressed.

Yes; But then during the time it is beyond its normal position—further from the speaker?—Your lordship corrects me. I should have said when it is to the left, not when it is moving to the left. The object of it is to get alternate electric currents between negative and positive rather than by variation of a single current.

Which would be more effective than variations in the one kind?—Which he thought would be more effective.

Mr. Plumptre: Have you ever seen a transmitter with a tension regulator of that kind?—No; I have not. By-the-bye, I think I have seen one in the Court.

I understood you to say that in the Edison transmitter the diaphragm is in contact directly or indirectly with the tension regulator?—Yes; it could not act without.

Do you find that opinion supported by the plans here?—I do; in every case I find them connected together. I should draw attention, however, to fig. 12, in which the connection is not a mechanical one, but an equally effective magnetic connection: that is to say, for some reason or other, a piece of iron has been fixed to the centre of the tympan.

Although there is no actual physical connection, there is a practical connection?—Oh yes; perfectly.

What is the function of the diaphragm introduced by Edison, generally speaking?—Its first function is to move to and fro with the waves of sound, and its second or effective function is to compress the tension regulator and to release it from compression during these vibrations.

Look at the defendants' instrument and tell me if you find anything in that in the nature of the Edison diaphragm?—Nothing whatever.

Have you heard it suggested in Court that the black cone or resonant case is a diaphragm? Do you agree with that statement?—Not only do I not agree that it is a diaphragm, but Mr. Edison gives it another name. He calls it resonant chamber, resonant box, or cone. I cannot conceive any person—any scientific man, any engineer, or patent agent, calling this circular piece a diaphragm.

Does the same thing apply to the black base?—Exactly the same remarks apply to the black base, except that Mr. Edison has not given it a special name, and I think includes it undoubtedly with the piece of which it forms a part, in the cases where he has anything corresponding to the black base. It is merely a means of attachment.

Am I right in saying that in all instruments for conveying speech there is something in the shape of a resonant case?—I won't say in all. One generally introduces something of the sort in a speaking tube, or anything of that sort.

For instance, in one of the earliest telephones, Reis's, there is something very large in the shape of a resonant box?—Yes.

Now, as regards the red back, do you consider that a diaphragm?—It is totally devoid of the characteristics required by the diaphragm or tympan of Edison, as I understand the Edison specification. It does not vibrate through an appreciable distance to the sound of the voice, and it is incapable of effectively compressing any tension regulator described in the specification. It is not a tympan or drum head.

Why do you say it is not a tympan or drum head?—Because it cannot move like a tympan. The tympan movement is a to and fro motion of the whole mass, and especially increasing towards the centre. Nor is it stretched in the manner of a drumhead.

Mr. Justice North: Well, Edison's are not all stretched, are they?—No.

Then it does not differ from Edison's?—I say essentially it will not carry out the function required of it. It has not that to and fro motion to produce a sensible compression of the tension regulator. If Edison had intended to use a thick piece of wood like this, he would not have described it as a tympan or diaphragm. He might, if he had wished to draw attention to the sounding qualities of it, have called it a sounding board; but a sounding board is utterly unsuitable for the purpose of his specification.

Mr. Plumptre: Have you ever heard it suggested, until this case came before your notice, that the red back or the black cone or the black case were diaphragms?

The **Attorney-General** objected. That was not a proper form, to suggest the answer.

Prof. Forbes: I ought to say that the definite primary purpose of these is to form a support for the instrument.

Mr. Plumptre: Have not all telephones some kind of support to keep them in their place?—Either to keep it in position, or to hold it in the hand.

You have, I think, performed some experiments testing the necessity of the presence of the red back in the defendants' transmitter?—I have performed a good many experiments upon this apparatus. The experiments which I have performed are important from a scientific point of view, as bearing very strongly on the *modus operandi* of the different parts. The first experiment which I made, if I remember rightly, was one in which I took the defendants' transmitter and first spoke to it in its natural condition and listened to it, so as to get accustomed to the loudness and distinctness and clearness of articulation. I then caused the black part to be lifted from the red board and spoken to, and I compared the result with the previous condition. I have tried this experiment a great many different times. On some occasions I have found it more distinct and better with the red back. I have sometimes found that when spoken to detached from the red back, speech was much more distinct and articulate than with it. It is also free from a certain general noise which is added to the articulation when the red back is used. I would account for that probably by the fact that the red board reflects the vibrations, and produces the effect of a person speaking in a room with an echo. I have, however, on several occasions found that the speech was both louder and more articulate when speaking to the instrument placed upon the base than when speaking to it in the air. On the occasions when I heard it so, the black part was put upon a solid mahogany table instead of being placed upon a red back, but I don't see that that has anything to do with it. Here I would direct your lordship's attention to the fact that telephone experiments, to be convincing, must be pretty frequently done, for sometimes a telephone requires considerable care in adjusting before it will speak to perfection; and another thing, I would mention that the general descriptions of the results as obtained are rather vague, and in most of these experiments I tried to introduce some definite test which I might give your lordship to show the relative perfection of the different parts. These were all the experiments I made with the two parts, complete or separate. The next experiment was with a black base like the previous one, but the two pencils were made of different materials. (Put in). One of the pencils is made of the ordinary hard carbon used by the defendants, the other was made of the mixture plumbago and gum rubber. The manner of its preparation was to dissolve the India rubber in naptha until it was quite fluid, then to mix with this fluid as much plumbago powder as possible, until it assumed a solid consistency and a large portion of the naptha presumably evaporated. The blocks were similarly made of the two materials. The hard carbon blocks were connected to two wires, which might be put in circuit with a battery and line wire. The semi-conducting blocks, the mixed rubber and the plumbago, were connected with two iron wires for the purpose of similar connection. Thus in the experiment I was able to use the same black part of the instrument, and introduce it for the hard carbon of the defendants, or the other arrangement separately. Speech from the hard carbon pencil was perfect. No sound whatever could be heard when the semi-conducting material was in circuit. I then instructed the assistant to break the contact of the one which did not operate—to make and break. A faint click was audible in the receiving instrument, but very very faint indeed. This showed that there was a very high resistance in that pencil. It also shows that a microphone made of such material will not work. The next experiment that I tried was with the telephone in Court made of lead. Lead is a very poor conductor of sound, and is not a material one would employ with which to make a sounding-board. Consequently, since it was my impression that a resonant case in the operation of the defendants' instrument had a great deal to do with the acuteness of the articulation, I expected to receive a very bad effect indeed from this apparatus, especially when held in the air and not resting on a piece of wood. To my astonishment this lead transmitter spoke admirably, whether I laid it upon the table or held it free in the air. This showed me that the resonance to which I had attributed so great importance was not so useful as I had thought. I looked at the lead to see if it was good lead, and it was the ordinary lead so far as I could judge. I then tried a very remarkable experiment indeed. It was remarkable to me; it might not be new to some. I had a large mass of putty, which has already been shown in Court; that mass, which has now settled down considerably, was raised up to a conical mouthpiece. We took a little trouble and time to adjust these carbons, so that they were quite free to move or roll about. There was only one difference between the putty as seen in Court and as I used it, and that is, I took away this piece of wood underneath, and instead, in order that there should be no sound vibrations whatever, I took a mass of straw and laid the free mass of putty on to the top of the straw. I attached great importance to this experiment, and was very much interested in it after my trials with the lead instrument. Having found that the resonant case was by no means so important as I imagined, I was prepared to hear the putty speak faintly, which I should not have been prepared for before; and I think other investigators of telephone matters would agree with me that it was very unlikely. Putty is a very bad conductor of sound indeed; it is so very, very imperfectly elastic. It is impossible to say that putty has no elasticity and cannot conduct sound, but I have no hesitation in saying that if I were in a room the walls of which were perfect non-conductors of sound except for a circular hole, and a piece of putty an inch thick was placed over that hole, I am perfectly certain I could not make noise enough to be heard outside. No one could say there was any vibration except the direct effect on the carbons from the voice. The assistant said, "Do you hear me?" "Do you quite understand?" "Do you hear distinctly?" These are the expressions one expects to hear. I heard them with startling loudness. I then told the assistant to read something more difficult, more unexpected. I shouted to him, "Something more difficult!" He took up a scientific book from my table and read to the putty. I was able to hear loudly, distinctly and articulately every syllable that he uttered. My opinion about this putty telephone was that it was as good as any telephone which I had ever listened to. But I have told your lordship that I tried to apply tests which would be of a definite nature and which would enable people to judge of the acuteness of the telephone when I heard it that day. Finding how perfectly loud and clear it was, I put this very severe test to it, which I had frequently applied before. I wrote on a sheet of paper a list of words which resembled each other very much except in the consonant. The words which I used were the following: "Meet, beat, wheat, seat, feet, heat, peat, sheet." These the assistant numbered, settling in his own mind the order in which he would call them out. When I heard the words I marked the one I heard, putting the numerals in the order in which they came, each of us having a list. With one exception our lists as marked corresponded; when he said "seat" I marked "sheet." And I should say that he marked "heat" as the eighth word but forgot to read it, and I had no mark against "heat." I considered this to be a most conclusive test. Anyone who has been in the habit of trying telephones, especially if they have applied this test for seven or eight years back, will know that it is a very severe test indeed. But while I was engaged upon these experiments, Mr. Conrad Cooke had come into my office, and after showing him some experiments, I resolved to try a test with his ears on an even larger scale. I chose the words: "High, thigh, why, nigh, sigh, die, my, tie, fie, by, lie, vie." To our astonishment, in every single instance in that list Mr. Conrad Cooke had, we found, identified the exact words which I had spoken to the putty telephone. Consequently, my opinion undoubtedly was that the putty was really an admirable material to make a telephone, with that particular kind of tension regulator. It would be utterly unsuited for the tension regulator described in Mr. Edison's specification, because it cannot act like a tympan and give a to and fro motion. On another day I tried the putty telephone again. Of course I had to remake it, because the material is so soft that in half an hour or an hour it collapses. On this occasion the telephone spoke as an admirable telephone, but I could not now say as I did before, that it was equal to any telephone which I had ever heard previously. This is easily accounted for, because the putty is so difficult to manage that it requires some skill to accurately fix the carbon blocks, and it is a matter partly of good fortune when they happen to be arranged in so movable a mass in the best position for speaking. I ought also to mention that on the second occasion I was using a different receiver. I have no means of knowing whether it was better or worse than the one I had used previously; but it ought to be mentioned. Having gone so far in the experiments I saw that my own previous ideas, and the ideas which I think would be most generally held by scientific men, were erroneous; and that the part of the telephone instrument which acts as a sounding-board has less influence than I thought in making the sounds loud, while it has a comparatively injurious effect in producing what I have described as an echo. From this experiment I judged that far greater clearness is obtained by having the mouth-piece at any rate of a material which does not conduct sound, such as putty. I then thought it would be worth while, if only for scientific interest, to pursue the experiment still further, and see what was necessary. Consequently, I took two pieces of red tape, and these red tapes were stretched from the corner of a mahogany table to a shelf. The carbon blocks of one of the defendants' instruments were glued on to the tape, wires being attached to them. The pencils were inserted, and then the carbons were placed into their proper relative positions. The only assistance in the way of support, to keep these properly adjusted, was the twisting of the wires round the tape, which enabled the carbons to be placed in their proper positions. On speaking to this instrument, I could understand my assistant when he said such things as "Do you hear me?" "Can you understand what I say?" I could hear the simpler and commoner phrases; but when he came to read from a book, I missed more than half the words. This showed that the arrangement acted very badly indeed as a transmitter. I now tried to imitate the action of a putty support to the blocks. That is to say, I tried to give a support to the blocks, and leave the pencils free to vibrate to the voice. The way in which I did this was to put sticks underneath the tape where the carbon blocks were, reaching to the floor. I was anxious to have no vibration given to the blocks, but to keep them fixed in position without receiving vibration from the tops of the sticks; I looked about for something soft to place there which would not conduct sound. Some one suggested a few corn plaisters, which answered admirably, being extremely unyielding, and practically non-conductors of sound. On speaking to this arrangement, it spoke very well indeed; not so well as the putty one, but short of that, very well indeed. Not only could I understand the commoner phrases, but when a book was read I followed every word easily and well. In fact, this arrangement answered as a good telephone.

What would be the object of securing a degree of steadiness for the support?—My object was to convince myself of what had seemed almost certain from my experiment with the putty—that is, if I could hold the blocks fixed in space and speak to the carbons, the relative motion which is thereby introduced would be just as effective as if I spoke to a sounding board and imparted a greater degree of motion to the pencils. We all know that the action of such microphonic arrangement is due to some sort of relative motion of the carbon blocks and the pencils, the pencils relatively to the blocks or the blocks relatively to the pencils. Hitherto I and other scientific men had supposed that the principal, if not the sole action, was the movement of the resonant box and the parts which acted as the sounding board, giving a motion to the carbon blocks, and that the inertia of the carbon pencils left them relatively at rest. After the putty experiment I felt convinced that the voice would act as well. The object of the tape experiment was to try whether the conclusions I drew from the putty experiment were correct, that if I could keep the blocks relatively fixed and let the sound waves act on the pencils, that that would act equally well. That certainly proved to be the case, producing the relative motion of pencil and blocks which everyone knows to be necessary. There was no resonant box there. When I held a paper cone with which to speak to the telephone on the tape it did not improve the articulation.

Mr. PLUMPTRE: With regard to the tension regulator, what do you find in the Edison specification spoken of as the material used?—I find seven different tension regulators, and the material varies, although one is repeated five times. That described on page 5, line 20, is made of fibre rubbed with plumbago, a soft compressible substance and a semi-conductor, and that tension regulator is described distinctly as being made of bunches, or tufts, or discs of semi-conducting elastic fibre, and an intermediate conducting or semi-conducting material. It is more or less compressed, according to the vibration of the tympan, and the electric current rises in tension as it is compressed or lessens as the fibre expands. The second one is at page 6, line 4, in which he makes use of a variable resistance resulting from greater or less intimacy of surface contact, such as would result from a disc covered with plumbago, placed adjacent to a diaphragm also covered with plumbago, or other semi-conducting material, so that the proximity or extent of surface contact will produce rise and fall of tension, the respective parts being in the circuit. The third is at page 6, line 31: "In some instances I make use of the best quality of lamp black, retained within a case, to form the tension regulator, the circuit passing through the same, and the rise and fall of electric tension resulting from the compression of the same by the movement of the diaphragm." The next one is on page 7, line 15. He says, referring to fig. 10, "H is the resonant chamber, at the end of which is the diaphragm, 10, and at each end of this diaphragm there are springs, c^2, c^3. having points made of compressed plumbago, mixed preferably with gum rubber, but any substance not liable to rapid decomposition, or the elastic or fibrous tension regulator aforesaid may be used." In the fifth (page 9, line 4), he describes another means of producing a semi-conductor, as in a previous way with fibre. The sixth is on page 10, line 3: "In preparing the tension regulator I find in some cases that it is preferable to use lamp-black mixed with pure plumbago, amorphous phosphorus, and a very small amount of non-conducting material, such as rubber dissolved in a solvent that will entirely evaporate." The seventh is a most peculiar one (page 11, line 4): "When the diaphragm is arranged as in figure 26, to act upon a spring, 56, it produces rise and fall of electric tension by employing a range of resistances, 57, with spring tongues adjacent to 56." On the top of the spring, zig-zag sort of springs up and down, one more contact at the foot of these zig-zags, so that as the spring which is in contact with this foot moves up and down, the greater or less number of its resistance will be introduced into the circuit.

What is the characteristic of the tension regulator?—In all these there are common facts. First, they must be semi-conductors, and secondly they must be compressible. These two things were both found by Lord Justice Fry to be necessary. He also includes resiliency. Of course it is necessary, when it has been compressed, that it should be again able to resume its primitive volume.

With regard to the compressibility?—I find generally that looking upon them practically and scientifically, whatever the different ways those things would act, theoretically, all these different tension regulators would act. I do not know whether they would practically act or not. My own impression is that they would require very large battery power to force the current through so large a resistance. The result of the thing is, to me, perfectly clear, and the mode in which Edison intended them to act is, I think, as clear as possible, and, as far as I am able to read them, I find that the tension regulator needs to be sensibly compressed by the to and fro motion of the diaphragm or tympan.

I think there was one tension regulator made combined of plumbago and the rubber?—Yes; that is not quite a form which is described in Edison's specification. I find that not only is there continual reference to the compression actually produced in the mass, but it is the only way in which I conceive the tension regulators which are described here would act. It is only by the squeezing of the mass, bringing more surfaces into contact, that the resistance would be varied.

Does the tension regulator of the defendants' transmitter in your opinion act by a similar compressibility as the plaintiffs'?—The defendants' instrument, to put it simply and shortly, does not act in this way, but is a microphone. The microphone is an instrument which was invented and discovered by Prof. Hughes in 1878, when he read a paper in May to the Royal Society.

Mr. MOULTON: That was after the publication of this specification; not only after the patent.

Mr. PLUMPTRE: What is the chief characteristic of the microphone action?—The microphone differed from all the things described in this specification; first in being a good conductor, being made of hard carbon, which is a good conductor. In one of its forms, broadly speaking, it consists of pieces of carbon which are in loose contact with each other, wires being attached to the collection of fragments on one side and another side of the apparatus. When Prof. Hughes produced it he always put it on a sounding board. He performed numerous experiments, one of them being to show that when a fly was walking upon the sounding board the minute shakes it gave to the loose contact always produced a tangible resistance sufficient to be heard loudly in a telephone, which was very startling. Then, on speaking to the sounding board and keeping the carbons in circuit, a voice was able to be heard in the telephone.

Am I right in characterising the defendants' tension regulator as being a microphone?—Undoubtedly.

Is a hard carbon, in your opinion, a semi-conductor?—No. It is usually classed among the good conductors.

Mr. JUSTICE NORTH: These pencils in the Theiler instrument are hard carbon, are they not?—I have never seen the Theiler instrument, but I think I know enough of it to say that they are. I want to make myself intelligible as to the qualities of carbon. The word "semi-conductivity" has never, so far as I am aware, been used by scientific men; it was introduced, I believe, for the first time by Edison. Electricians ordinarily divide all bodies into two classes—good conductors and bad conductors. Accurate men try to avoid the word "non-conductors," which used to be employed, because nothing is a non-conductor as far as we know. There are some things—like water or wet wood—which are good conductors when we are considering the question of insulation, and bad conductors when considering the question of making an electric circuit for a battery. The good conductors, so far as I have heard, include only the metals and carbons. The very bad conductors include india rubber, gutta percha, silk, glass. The meaning of the word semi-conductivity is perfectly evident to me in this specification, because I find that throughout it always refers to a mixture of a good conductor, such as a metal or carbon, with a bad conductor, such as silk, india rubber, or air.

I think you heard me ask Mr. Imray, yesterday, what was the next conductor, as regards capacity of conducting, after carbon, and I think he told me paper soaked in sulphuric acid?—That would be one of the worst ones, I dare say. Water is more than a million times worse than carbon; paper and water would be still more, and sulphuric acid would still further increase the resistance.

I think the next point is the resiliency of the carbon.—I think the fact is self-evident that after a thing has been compressed out of shape it must have resiliency to return to its original volume in shape.

Cross-Examined by the ATTORNEY-GENERAL: When did you make the experiments which you have been explaining?—I made a good many in the course of the last week. The most important ones, I presume, were those in connection with the putty. Those were on Tuesday.

I want to get it from you distinctly. The chain of experiments on which you have based your argument were practically made within the last week or fortnight?—All except the difference between the defendants' instrument when on a back board and when held in the air.

When was that made?—That I made first a month or two ago, I should think—several months ago.

When were you first consulted about this case?—I cannot fix the precise date. I can tell you, it was March last, because I saw a letter this morning.

You did not, I believe give evidence in either of the other telephone cases?—No.

You were acquainted with the names of the gentlemen who were called before Mr. Justice Fry?—No, I was not.

I will give them to you: Professor Sylvanus Thompson, Mr. Alexander Muirhead, Professor Dolbear, and Professor Ayrton. All of them skilled electricians, are they not?—Some of them are.

I do not want to draw any comparisons. They are skilled electricians?—I should think so.

You do not know whether either of those is here or not?—I think we heard that they were not; that is my only means of knowledge. I knew that Professor Dolbear was in America, and I knew that Professor Sylvanus Thompson was not here. I have not heard of any of the others.

You are yourself an inventor in electrical research, and a patentee, I believe?—Yes, I once patented a dynamo machine.

You have not yourself patented any telephone?—No.

In the evidence you have given before the Court, do you say you are speaking with the knowledge that people had in 1877, or with the knowledge people have to-day?—As to the remarkable results I got in the course of these experiments?

As to the scientific inferences you have drawn from the experiments you have given. Do you represent that the knowledge which you have been stating was all of it known in 1877?—It is very difficult to answer that question, because I have to go through the whole of the remarks I have made.

I really do not want to trouble you to do that, but you will have an opportunity, and I will put it to you more pointedly afterwards. In the first instance is it not a fact that we know a great deal more about telephones in 1885 than was known in 1877?—Certainly.

You became acquainted with Bell's telephone in that year?—In 1876 I heard Sir William Thomson describe it in Glasgow.

Prior to that year you had never seen an articulate telephone?—I had not.

When did you first see a carbon tension regulator in a telephonic circuit?—I am nearly certain it was in the summer of 1878. I think it was about the time of Professor Hughes's experiment, or just after that. By the carbon tension regulator I of course include the microphone.

Taking the whole of Edison's specification and referring to any passage you want, is there any function shown anywhere or indicated anywhere for the diaphragm excepting collecting or influencing or taking up the sound waves? Is there on the face of the specification any other function shown for the diaphragm except what you have called taking up the sound waves?—Yes.

What is it in the first instance?—The compressing the tension regulator. That is the first.

Do you wish to add something?—I think there is something. I do not know whether it will be right to say it—to complete the electric circuit in its centre.

I appeal to you once for all, and I am sure you will endeavour to answer my questions fairly, but kindly apply your mind to the point I am upon.—I fail to see it.

Is not what you have called the separate function simply the result of taking up the sound waves?—That is a different question to what you put before.

You must answer my question. Is not what you have called a separate function, that is to say compressing, I think you said, the tension regulator, simply the result of its taking up the sound waves?—Certainly it is.

Now, I will have it clearly if you please. Except the taking up the sound waves and with them acting upon the tension regulator is there in this specification a single function of the diaphragm described?—To the best of my knowledge, no.

And I put it to you as a person of great scientific knowledge, taking any form (speaking of them as a class), is not that the only function which as a fact the diaphragm performs?—I think so.

Now take for a moment the tension regulator in this instrument. I am not cross-examining upon any particular form of tension regulator. Speaking to that instrument with the slat of wood before you, does not that slat of wood perform the function of taking up the sound waves and with them acting upon the tension regulator?—It takes up the sound waves, and it acts upon the tension regulator.

The same functions as you have just before given me fairly enough as being the functions of the diaphragm in Edison's specification?—Yes, but in a totally different way.

We will deal with the different way in a moment. Does not that slat of wood in this Ader instrument receive or obstruct the sound pulsations and send them forward to the tension regulator in the same way as the diaphragm in Edison's specification ?—No, I do not think so.

Why not ?—Because it seems essential to me that there should be a direct tympanic motion in Edison's transmitter, which was totally absent in that apparatus.

Please understand me. I am not upon the question of the words "direct tympanic." I ask you to remember what you told me a few minutes ago, that the only function of an Edison's diaphragm was to take up the sound waves and by those sound waves compress a tension regulator. I put it to you, asking you to answer me carefully, is not that identically the function of this slat in Ader ?—I think that slat takes up the sound waves and acts on the tension regulator, but I am not sure of the action.

Why can you not say "Yes" ? You have adopted the whole language. Does not that slat of wood take up the sound-waves and with them compress a tension regulator ?—I should think to a great extent it compresses a tension regulator. Otherwise I say, unqualifiedly, yes. I think you may say that there is a compression of that point of contact.

You said, in examination-in-chief, that you had never seen Theiler's. Look at this ?—No; I said I saw it in court the other day, and it was for the first time.

In that we have what we will call for the moment the diaphragm —metal and cork—a "knocker," as my lord called it, very aptly, which consists of a piece of hard carbon with a metal back to give it weight, resting, by the force of gravity, against two hard carbon pencils. That is a correct description ?—Yes, quite clear.

Did you know it was alleged in the Glasgow case that that was not a diaphragm ?—No, I did not. I did not follow either of those cases.

I am only putting a fact to you. Is it, or is it not ? The metal and the cork—I am not distinguishing between the two ?—I should say yes.

Now, in that case, is it not true that the only function of that sheet of metal and cork is to take up the sound-waves, and with them, act upon the tension regulator that is behind ?—Yes, that is my opinion.

Looking at the Gower-Bell instrument, apart from the particucular form of tension regulator, does not the piece of wood take up the sound-waves, and, with them, act upon the tension regulator ?—Yes.

Now, I take Ader, and assuming that either of these three—Ader, Gower-Bell, or Theiler—are within the plaintiffs' specification as a matter of construction, do you suggest that it is an infringement if you speak to the board, and not an infringement if you speak to the tension regulator ?—Most certainly not. Assuming that these fulfil the conditions of the Edison transmitter, I certainly do not say that it would diminish the infringement to speak to either side.

Do you not know that for commercial purposes they speak equally well, whichever side you speak to ?—Yes, I think so. That is my experience.

You have been in court during the whole of this case, and have heard Dr. Hopkinson examined ?—Yes.

I have no doubt you are acquainted with him and know him as a scientific gentleman ?—Yes, I know him intimately.

And I suppose you are acquainted with the other gentlemen examined ?—I think I am acquainted, more or less, with all.

Do you represent that the eight experiments spoken to by Dr. Hopkinson were not correct experiments, or truthfully related ? —I really have not sufficiently definite recollection of so many as eight.

You were present in court at the time, and heard these experiments, no doubt with interest. Was there one single one of them which at the time you thought was incorrect or not accurately stated—I will not suggest "untrue," of course—but accurately stated ?—I have no recollection of such an impression having passed my mind.

Diaphragms are well-known things in connection with optical instruments ?—They are.

They may be closed or perforated diaphragms ?—Yes ; in optical instruments they are, as a rule, open—perforated.

Just take the black base and the mouthpiece of the defendants' transmitter together. Will you kindly look at this, which I tell you is made to the exact pattern. It is part of the black base, or it would be if it were sawn off. You can test it in any way you like, but I think you will find it is mathematically accurate ?—I see it.

Now assume the thing together, that is to say, the mouthpiece and the black base—put in connection with the line of a "lover's" telephone, and that articulate speech is heard at the end of the line in the way, quite apart from electricity, that we understand the "lover's" telephone to act. I ask you to answer me carefully. Must not that have been caused by the interference of the black piece of wood—I am not dividing the parts for the moment —with the sound-waves ?—No; by the production of the sound-waves by that piece of wood.

I will take it in your own way. I think I was right when I said "interference." Just consider for a moment. The sound-waves come from the voice in the first instance ? Will you answer that ?—Yes.

That is, obstructed by some parts of the wood and then re-produced so as to be transmitted through the line ?—Put in that way the word "interference" is quite correct.

Mr. Justice North: It must be owing to the direction of the sound-waves ?

The Attorney-General: Which are themselves produced by the voice ?—Undoubtedly. I meant production in the solid parts.

Please do not alter my words unless it is necessary ?—I really do not understand them.

That is, by the interference with the waves which come from the voice by the wood ?—Yes.

Would not that be the to and fro motion of the parts of the wood in the sense in which you used "to and fro" in your evidence-in-chief ?—Would "to and fro" in that case mean along the line ?

You, in explaining the action of a diaphragm to Mr. Plumptre, spoke of a to and fro motion ?—I did.

I care not in what line it is, or perpendicular to what plane it is. Would not that result be produced by the to and fro motion of the parts of the wood ?—Certainly.

And would not that flat base which I have cut off, and which is now before you, act in the same way as the diaphragm which is described in Edison's specification, so far as the interference with the sound waves is concerned ?—It would interfere with the sound waves certainly.

I ask for an answer to my question, unless it requires explanation. So far as the interference with the sound waves is concerned would it not act in the same way as the diaphragm in Edison's specification ?—No, I think not.

Why not ?—Because it does not seem to me to act like a tympan, as in the Edison one.

I appeal to you not to refer to particular words, which, to my mind—I may be quite wrong—are perfectly immaterial. I ask you please to deal with the substance of what I am putting to you.—I meant the voice does not act directly on this.

I never said anything about acting directly. I ask you whether or not the black base acts, so far as interference with the sound waves is concerned, in the same way as the diaphragm in Edison's specification ?—I think not.

Why not ?—It acts through the intermediary of the mouth-piece, and not directly.

Do you really mean that ?—I really do.

I ask you, speaking into that tube, do you represent that the sound waves would not act on the outside of the black base, and independently of what you speak of as being through the tube ?—To a very feeble extent, because they have to go round a corner.

You have drawn the distinction between sound waves acting on the black base and sound waves acting through the mouth-piece. Do you represent, giving of course your evidence with great care, that the sound waves do not act directly upon the annular disc which projects beyond the mouth-piece ?—They certainly will act upon this annular disc.

Mr. Justice North: I understand you to say only very faintly. —I believe so; they do not act directly.

The Attorney-General: I am coming to that. Have you made any experiments, that you suggest that they would only act very faintly ?—No; it is evident from knowledge of the subject.

I will assume any amount of knowledge, and you shall assume the ignorance with which I may sometimes make a mistake. Why, for this purpose, if there was a flat board across and no mouth-piece do you not think it would speak equally well on a "lover's" telephone ?—Equally well as if it was closed ?

Equally well as if it had a mouth-piece on it ?—I should say better; I think so. I ought to understand this quite clearly. My own impression is that it would act better than with the mouth-piece; but I cannot be sure.

What I put to you is this: Having regard to the slats which I have called your attention to in Ader, in Gower-Bell, and what I may call the disc in Theiler, to the shapes in Edison's own specification, and to the Blake, does it make a particle of difference for the purpose of combination, what shape the piece of wood is except in degree, whether it be a "lover's" telephone or an electrical telephone ?—No; I think not, except in degree.

You have said, and I tell you frankly it is the only answer which I was sorry for the moment to hear, that the red back did not move to and fro. Have you made a single experiment by which you would pledge your scientific knowledge to that ?—It vibrates; therefore there must be some sort of motion to and fro. I meant there was no appreciable to and fro motion.

Now, do you represent that that red back will not perform the same functions as the diaphragm of Edison, so far as the interference with the sound waves is concerned, and acting upon a tension regulator ?—I think the answer which I gave in my examination-in-chief is an answer which would apply to that.

I would rather you answered my question. I am entitled to an answer. Do you represent that the red back will not perform the same functions as are to be performed by the diaphragm of Edison, as you yourself described them—the interfering with the sound waves and the acting on the tension regulator thereby ?—It would not act upon his tension regulator.

You have no right to put in "his tension regulator." I said, "acting upon a tension regulator."—You said "acting in the same way." I readily admit, I think, what you want me to say—that it would interfere with the sound waves. I think it would add to the vibrations of the wooden parts of the instrument, and so act on the tension regulator.

You have told my lord that you yourself had spoken to the under side, as I call it, of that red back.—I do not remember having said so.

I understood you to say so, but I may be wrong. Have you tried the experiment, and do you know that speaking to the under side of that red back it speaks perfectly well?—I have no doubt it would speak.

Mr. Justice North: Have you tried it?—No, I have not.

The Attorney-General: Have you a doubt about it?—I am sure it would.

Why did you not say so?—Well, I was not asked.

Have you a doubt that that red back would speak through a toy telephone, by which I mean would catch and produce the sound waves in the way you have described?—I am sure it would be a very good thing to attach this to in that arrangement.

Reminding you of what you have frankly adopted, and what has been proved to my lord before, that speaking to the back of this red board you do operate successfully upon the tension regulator, must not that be by the to and fro vibrations of that red piece of wood?—It must certainly, by the vibrations.

I am not speaking of to and fro in the way you put it.—Well, I gave a direction when I spoke of to and fro.

You put to and fro upon us to distinguish the diaphragms in Edison's case, and you spoke to me about going round a corner. Is it not the fact that when you act upon the tension regulator it must be by the to and fro vibration of that piece of wood—of course, when you speak to the underside?—I think so; I think you may safely say so.

Mr. Justice North: If it is not from that, what else can it be from?—It is a little confusion caused by the expression "to and fro."

The Attorney-General: From the vibration?—Yes, I would rather you said that.

Mr. Justice North: Does it come from the vibration?—Yes. When I was using the words "to and fro" in my examination-in-chief, I was talking of a visible, sensible motion to and fro.

What is the difference between that and the motion you were speaking of a moment or two ago?—The motion in a sounding board is very difficult to follow.

The Attorney-General: You have pointed out that when you speak to the back of the defendants' apparatus it operates upon the tension regulator by the vibration of the piece of red wood in a plane perpendicular to its plane?—That is true. I do not exactly admit that.

Is it not so?—Perpendicular to its plane?

Yes.—I should think a great many of the vibrations are perpendicular to its plane; but most of them are along its length.

But those are not the vibrations which compress the tension regulator?—I think it compresses the tension regulator through the back part.

I do not think that is quite a candid answer, if you will forgive my saying so. The tension regulator is attached to the piece of wood?—Yes.

Would it make a particle of difference whether those square blocks were fastened directly on to the red back, or fastened on to the black bit of wood attached to the red back?—I think it would probably speak better if attached to the red back.

For the purpose of action, would it make any difference when you were speaking from the back whether the blocks were fastened on the inside of the black piece of wood which is attached to the red back, or on to the red back itself?—In both cases it would speak.

Mr. Justice North: Would it make any difference?—It would speak better in one case than in the other.

Which the better?—I am not sure.

The Attorney-Genelal: Do you not think it would speak better when fastened on to the red piece of wood?—I should be inclined to think so. I do not know that it would speak so loud, but I think it would be more distinct.

I did not know it was in Court, but that (instrument produced) is what I was putting to you at the moment. Now, in your judgment, in the first place, would it not speak perfectly well when you spoke to the back?—Yes.

Mr. Justice North: What is that?—It is a common microphone.

The Attorney-General: It is a tension regulator put direct on to the board.

You have conceded to me that that would speak when spoken at from the back?—Oh, certainly.

Would not, then, the operation of that red back be identical with what you describe as the operation of the diaphragm in Edison's case, so far as the picking up of the sound waves, and the sending them forward is concerned?—Certainly; it picks them up and sends them forward, as does the Edison.

Did you make this exhibit (the leaden cone)?—No; the defendant.

Do you represent this is made of lead in the sense of being dull metal, which is not a good conductor of sound?—I think if I were to order a lead thing to be cast a certain shape, it seems to me, as far as I could judge by examining it, that that is the sort of material that would be produced.

Does antimony increase the resonance very markedly?—It makes it harder, and that is what is wanted in resonance.

Would not that act as a "lover's telephone"?—I cannot say.

What do you think?—I should say very badly.

Would it vibrate to send the waves of sound along a "lover's telephone" wire?—I should think it might a few feet.

Would not that act by vibration to-and-fro of the parts of the thing, whatever you call it?—Quite so; undoubtedly it would—it must be so.

Have you the slightest doubt that it acts upon the electrical telephone by the vibration of its parts in common with the direct waves of the voice?—I should say they certainly contributed their part so far as the lead is a conductor of sound.

In other words, in so far as it would act as a vibrator?—Yes.

Now let me call your attention to two or three other experiments which were sworn to by Dr. Hopkinson in your hearing. The central tube of the mouth-piece, the tension regulator being put on one side; that is to say, the central tube taken downwards, so that the direct rays could not impinge upon the tension regulator?—I remember the experiments.

Assume that to have been truthful, which I know you do not suggest the contrary of, and that that spoke in an electrical telephone, as Dr. Hopkinson has said, must not the compression of the tension regulator have been brought about either by the vibrations of the mouth-piece and black base, or by the reflected vibrations of the red back?—Yes.

Mr. Justice North: Or both?—Yes, or both.

The Attorney-General: You agree that if a diaphragm was to be described to have the functions which you have given to it, or admitted to me that it has, in Edison's specification, the best description of a diaphragm would be of the class that is shown in his drawings in the specification—the natural form of diaphragm?—The best form of diaphragm. I understand your question. It depends what the purpose was for.

I am speaking of interfering with sound waves and transmitting them to tension regulators. I mean those two functions which you have more than once agreed with me are the only functions of the diaphragm in Edison's specification. Given that to be the proposition, is not the form of diaphragm, or the class of diaphragm, shown in the drawings that which would have been considered in 1877 as the best form of diaphragm for the purpose?—I should say so. They give the greatest vibration, and I presume that is what you want.

It would not be an unfair thing to say that, with the then knowledge it was the best form of diaphragm?—I would rather put it that it gave the greatest vibration, if you will allow me.

I have enough for the purpose of that to argue to my lord afterwards. I do not think you would intentionally say anything unfair with regard to this gentleman's invention, but do you suggest that either in the face of the specification or having regard to the functions of the diaphragm, that it makes the slightest difference whether the diaphragm is at the side, in between, or at the back of the tension regulator?—No, I do not think it does.

Mr. Justice North: I think he said that before; that it makes no difference whether it is between the speaker and the diaphragm.—I think it would act in every case.

The Attorney-General: Either in front, behind, or at the side?

Mr. Justice North: Yes.

The Attorney-General: It is not material now, but it is exceedingly remarkable how it is described in the specification. You think it would not make the slightest difference whether it is in front, behind, or at the side, or whether the voice went directly to it, or was deflected to it?—That would only affect it in degree.

Now, I will just make good for the purpose of my lord's reference those two. With regard to the side, it is at page 6, line 15, "In some instances two or more diaphragms are provided at different sides of the resonant box, each with its own tension regulator;" and with regard to the deflection of the voice, it is at page 5, line 1. Were you aware that Mr. Edison also described a diaphragm in his specification which would not be a complete separation in the way you have described it?—No, I do not know it.

You told my lord that the diaphragm, as you understood Mr. Edison's specification, was a diaphragm which completely separated one part of the instrument from the other?—That was my firm impression.

Do you know now whether he actually describes a diaphragm which is not a complete separation?—No, I am not aware of it.

I will, if I can, enlighten you upon that. I will ask you to read the passage at page 8, line 43: "A plate supported excentrically and free at its edges when placed in the speaking tube responds advantageously to the tones of the voice; the circuit with the plate is completed through one or more tension regulators placed around its edges." You were not aware of that?—Oh yes; I have seen that. I read it in a different sense.

You agree with me, that it is a tongue vibrator, or at any rate not a complete diaphragm right across?—I read it as a complete diaphragm right across, and it seems to me to be so still, supported excentrically.

Free at its edges?—No, as separating one part from the other.

I think I was right for once; will you not give it to me?—Certainly, anything you want.

"Free at its edges," "supported excentrically." Do you observe that?—Yes.

Does not that dispose of what you believe to be a distinctive feature of the Edison invention, that the diaphragm must always act by its centre on the tension regulator?—I think it does. That reference was not in my mind at the time I gave that evidence, but the remark at page 5, line 33: "In all instances the telegraphic circuit at the diaphragm is made by a thin strip of platina or similar material extending to the centre from the line or battery connection." That led me to think that in all the things he implied that was the case.

He is speaking of the particular figure?—No; he says, "in all instances."

We will not criticise it. You agree with me that the class you drew is not consistent with page 8, line 43?—It is not.

When was it you tried a putty experiment? Was it last week?—No, this week.

You have never seen a commercial putty telephone?—No, I should like to, though.

Perhaps we shall have the honour of your bringing out a Putty Telephone Company?—No, that is not in my line.

You do not suggest that you have ever seen a commercial article in use as a telephone such as the putty arrangement?—No.

What led you to try the putty?—I was shown a putty telephone. It was seeing the putty telephone that made me first try it. Other people had tried it.

You knew the putty experiment was before Mr. Justice Fry, did you not?—I heard Sir William Thomson, in this court, say something about a putty telephone; that is all I know about the previous trial.

And having heard that, you went away and tried your master-hand at it and succeeded?—I think I tried it before Sir William's evidence.

I thought you said that was the first you heard of it?—I said the first I heard about the telephone which was before Mr. Justice Fry.

You tried it before Sir William Thomson gave his evidence?—Yes. I tried it before Sir William Thomson gave his evidence.

You simply took it by the light of nature?—No, I did not: I saw a putty telephone.

Who showed it to you?—The defendant.

Mr. Bassano told you of the putty telephone incident, and you reproduced it?—No, I made experiments with it.

I call that reproducing it. At any rate it never entered your head to use it until it was shown to you by Mr. Bassano?—I assure you it was a revelation to me, the results I got.

You said (I admit you rather went back from it afterwards) at first that the tension regulator was to be in between the voice and the diaphragm. You did point out that you thought there was nothing to justify that?—I say the tension regulator described here.

Just look at fig. 10 a moment?—I know it well.

You have pointed out yourself, and therefore I have only to remind my lord of it, that the connection is with a different part of the battery on the two sides?—Yes.

Am I not correct in saying that the connection of the tension regulator, so far as the current, that is to say, the current which runs through c_2—that is the left-hand side—with the zinc—do you call that negative or positive?—That is connected with the zinc, and it sends a negative current.

That the increase or diminution of the negative current would be due solely to the action of the diaphragm on the left-hand side?—Yes.

It would not be in any way dependent upon the action of the other compressed plumbago point, which is c_3?—No, its diminution would not.

Because, as you have pointed out, they are two currents, in one sense—they might come simultaneously, but it is an increase either of pressure or compression, which increases or diminishes the negative currrent to the left?—Yes; increases or diminishes.

And exactly the same to the right?—Yes, exactly the same to the right.

Therefore that is a distinct case in which a regulator acts upon the outside of the diaphragm—the further side of the diaphragm?—It acts upon both.

So far as c_2 is concerned, you are aware also that he points out that those may be used on one or both sides?—I had forgotten that at the moment, but there is no doubt they can.

I will make it very plain. It shows in fig. 11 a U-shaped spring which is to carry those two carbon points. It is page 7, line 37. "In fig. 11 is shown the contact spring, which may be used adjacent to the diaphragm, at one or both sides thereof."—I ought to read through the description?

If you want it, but I could tell you what it is. It is correct as I said; it says it may be applied in one or both sides.—Oh, certainly.

Now, I understand you to say that one reason why this mouthpiece, which I admit is not a material part of the combination, and I am not going to suggest that it is in what I am putting before my lord; but you said one reason why this could not act as a diaphragm was because it was round?—Did I say that?

I understood you to say so.—I do not remember; but I think it is a very valid objection to it.

Do you adopt it now?—Yes, I think I would. In ordinary parlance, I never saw a diaphragm with a curved surface.

There is a square resonant box with a tension regulator on the outside. I am taking Edison, pure and simple, for this purpose. The person who speaks into that box would vibrate the end of the box as well as the side, and would thereby act upon the tension regulator?—Yes.

Supposing, for purposes of convenience, it was thought fit to make that box fit into a hole of a round shape like that (illustrating), would not that act equally well?—Yes.

You talked a good deal about compression and pressure. Is there any difference for the purposes of electrical contact, except one of degree, between compression, pressure, and extent of surface contact?—They are totally different things.

You call them totally different things?—Yes.

I do not think you mean that?—I think we shall come to understand each other very quickly, but I like to be exact.

Extra surface extent means the surfaces close together?—Oh!

Well, does it not?—I do not see it.

Just look. Suppose you have two surfaces, and they are in contact, and you so put them that there is more of the surfaces in contact, does it not follow that they are closer together?—Yes, I think so in that case.

That is the particular case I am putting to you. Does not that fact of bringing two surfaces already in contact closer together involve increased pressure?—Yes; that is a totally different way of putting it, and I cordially agree.

Do answer my question, and do not criticise whether I put it rightly or wrongly. Does it not also show that every pressure involves compression of the particles which are at the surface?—It would involve compression of the mass. Whether it would involve compression of the particles or not I would not be so sure.

The particles might be displaced, as you put it, or they might be compressed. Does it not follow that Mr. Imray was correct when he said that surface contact, pressure, and compression interlaced and ran into one another?—I think Mr. Imray put it better than that. I think he said that compression is the result of pressure.

I have no doubt; but I will endeavour to put it not so well, and to ask you whether it is not that intimacy of surface contact, pressure, and compression overlapping one another?—It is a curious overlapping. It produces compression, and when you have compression you very often have greater intimacy of surface contact. I think that is what you want.

Mr. JUSTICE NORTH: You mean they are found existing together?—Yes; pressure is the cause of compression—produces the compression.

The ATTORNEY-GENERAL (producing the instrument with the carbon blocks and pencils of different materials): Did you make what you call the rubber pencil?—No; the defendants.

Did you test it for resistance?—No, I did not.

Did you test it for weight?—No.

Did you examine it to see the degree of surface in contact?—I did.

Relatively?—How relatively?

As to whether there was the same number of decimal points on the square inch, or whatever the proper way of measuring it would be, in the points of contact of the two pencils?—No, I did not.

Now, you said that the result of your experiment was to show that the rubber pencil was of much higher resistance than the hard carbon pencil?—Yes.

Would not that be simply to necessitate an increase of battery power?—If you use a very powerful battery that would get over the difficulty so far as that is concerned.

My question is, would not what you have pointed out as the obstruction be overcome by the increase of battery power?—The resistance would be completely overcome by the extra battery power.

Now, is it not a common thing, when you are dealing with electrical conductors, that you have to adjust the amount of surface in contact, the battery power, and the way in which the conductor is arranged in accordance with the particular resistance you are using?—Undoubtedly.

You have said that "semi-conducting" was not to you a scientific word, and it was to you apparently an unknown and perhaps inaccurate mode of expression in the year 1877?—Extremely accurate, but otherwise unknown to me.

Now I put this to you, dealing with plumbago point pure and simple, which is mentioned in three or four places in the specification. Page 7, line 16: "Having points made of compressed plumbago, mixed preferably with gum rubber." You are aware that if a man puts into his specification, "mixed preferably," that he thereby implies that he may use them if he likes?—No, I understood that totally differently. The interpretation I put upon that was that it was mixed preferably with gum rubber rather than with any other non-conductor.

Do you know one way or the other, or have you sufficient experience in these matters to know, that a common way of expressing two things to be used, is to say that you use one preferably?—Yes.

Has it come before your knowledge that unless both act the specification would not be good?—Yes, I know that.

Now look at page 6, line 5, "disc covered with plumbago." That would be a pure plumbago contact, would it not?—It would be a plumbago powder contact, which is really a mixture of plumbago and air—a good and a bad conductor mixed.

Would not that be a simple plumbago contact—a disc covered with plumbago? The contact would be in the plumbago?—That is a passage which is really very incomprehensible to me, the whole of it.

It is "a disc covered with plumbago, placed adjacent to a diaphragm also covered with plumbago, or some other semi-conducting material, so that the proximity or extent of surface contact will produce rise and fall of tension." Would not an electrical engineer, bringing a willing mind to bear, understand that to mean two plumbago contacts?—It undoubtedly says that the two things covered with plumbago are in contact.

That would be two plumbago contacts?—Undoubtedly.

Now, compressed plumbago would be something like the point of a black-lead pencil?—It might be.

That would not be an inapt description?—No.

Now look at this (*handing up a specimen*), that is plumbago?—It may be. If you say it is I will take it.

I will not put it higher than this—a contact indicated as one which would do as a plumbago contact? That last reference that that thin layer was a plumbago contact?—I agree with you.

If I am correct in saying that that passage meant a compressed plumbago point, without any stuff mixed with it, they would be two forms of plumbago contact, if they are in the specification ?—They would be two forms.

That is all I ask. I put it, founding a question upon it. You do not know that those are the carbon points ?—What are ?

Plumbago ?—Oh no.

They are.—Plumbago is a form of carbon.

And a compressed plumbago point would be a compressed carbon point ?—I do not remember that passage—"pressed plumbago point."

Assume it is there.—Compressed plumbago point, pure and simple, is a point made of compressed plumbago.

I put to you compressed carbon.

Mr. Justice North: It is made of compressed carbon ?—Which ?

A point made of plumbago is a point made of carbon ?—Yes; undoubtedly.

The Attorney-General: And a compressed plumbago point is a point of compressed carbon ?—Yes.

Now, the effect of doing something with compressed plumbago would be only to vary its resistance, either to make it a better or a less good conductor ?—Two things, varying its resistance and making it more compressible.

It might be made less or more compressible ?—Of course it could be done.

It might alter its resistance by making it a better or worse conductor, and it might alter its other characteristics ?—Yes.

Is not a carbon or whatever is intended to be inserted as a tension regulator something which is to be put in electrical connection with the line wire ?—Yes, I understand it so.

That is the principle of it ?—Except in the case that Mr. Moulton spoke to me of.

The line wire, of course, would be one of the best conductors ?—Presumably.

You would never make a line wire of carbon ?—No. I distinctly told his lordship so this morning.

The line wire, speaking to an electrician, would be one of the best conductors—probably copper ?—I should think it would be one of the best conductors.

Would it not be perfectly correct to say that as compared with the material which would be used for the line wires, the carbon tension regulator would be very much worse as a conductor—about 2,500 times the resistance ?—Of copper.

And infinitely better than the other things which you have mentioned, which came so far behind; I think you said glass ?—Yes, infinitely: millions and millions.

Given line wire, of course of the best kind of conductivity, and carbon coming behind, as you put it, at a considerable distance, would not a semi-conducting material of the same character as compressed plumbago, include compressed carbon ?—I do not know, really, that that is a question that I am competent to answer. I should think very likely; I think it is a legal question s to that consideration.

Would you decline to answer it ?—Whether the compressed plumbago would include——?

Compressed carbon, when it is to be used as a semi-conducting medium, in contradistinction to the line wire ?—I do not quite follow that.

Mr. Justice North: Just tell me this. Would a semi-conducting material of the same character as compressed plumbago include compressed carbon ?—Generally.

Yes ?—I do not know.

Is not compressed carbon a semi-conducting material of the same character as compressed plumbago ?—Yes; in fact, compressed plumbago is compressed carbon.

The Attorney-General: In relation to the line wire it is the same material ?—Both of them would stand in very much the same relation as to conductivity.

And the actual shape, size and weight might be varied with the class of carbon that you took ?—Size and weight of what ?

Of the tension regulator.—Might be varied—— ?

Might be varied with the class of carbon that you took ?—I should say the variation of size.

I meant, as involving weight, keeping a certain amount of surface in contact normally, having regard to the strength of the battery with some carbon you might like a heavier block, and with other carbon you might like a lighter block ?—That is quite clear; you would.

In a properly adjusted microphonic transmitter, as you have been pleased to call it, according to the carbon which you used, will not the resistance vary either by intimacy of surface contact, pressure or compression ?—I agree with Sir Frederick Bramwell that I cannot say what is the cause of the microphonic action.

That is not my point. I do not say the cause of the microphonic action. I am not now dealing with the cause or how it acts. In a microphonic circuit, where carbon is used, will not the resistance vary with either surface contact, pressure, or compression—one of the three ?—I cannot say as to that. A very large number of laboratory experiments have been made, some by myself, some by friends, to try exactly and find out how it is that the resistance is varied, whether it is by compression, by a rolling and varying surface, or whether, as a very large number of scientists hold, by an actual arc passing through the air, across the carbon——

Do not get into the Royal Institution frame of mind for the moment. Speaking of it, not with what scientists are to find out to-day, but with the knowledge of 1877, would you not say with the then knowledge that the variation of resistance depended upon either intimacy of surface contact, pressure, or compression ?—I should think very likely I would have said something of that sort.

You have drawn a distinction between pressure and compression. You have said one is the result of the other. If you are using compressed charcoal points, whether you get compression or disturbance of the particles will depend upon the degree of the compression that you start with ? I mean if it is a very hard block it will not be compressed much, but some of the surface may be a little disturbed ?—I should think so.

That if you are dealing with a compressed block, perhaps it may be pressure in one state of things and compression in another state of things ?—I do not understand you.

The compression is the result of pressure in both cases ?—In both which cases ?

In the case of a harder compressed point and a softer compressed point ?—Of course, compression is the result of pressure in both cases.

Re-Examined by Mr. Plumptre: It has been put to you that the black cone, the black base, and red back resound, and that therefore they are all diaphragms. Now, in this (a model of the plaintiffs' fig. 1) have you the same parts ?—I have practically the same parts, except that this has something extra.

Then you have what has been called the true diaphragm in the centre there ?—Yes.

Taking the construction of the word which has been put upon it—namely, anything that resounds—there would really be four diaphragms in that apparatus, would there not ?—Distinctly.

Have you any doubt in your own mind, when Edison says he claims a combination diaphragm with a tension regulator, what he means ?—I have not the slightest doubt what he means.

What do you say he does mean, once more ?—This plate, in contact with the tension regulator.

If you took that diaphragm away, do you think the machine would act, if you used any tension regulators mentioned in the specification ?—No, certainly not; that is to say, according to my view, that all these were compressible materials, that is my distinct impression from reading the specification. I do not wish it to be implied that I have said that if this specification includes the light contact of hard carbons, that that would not act.

To your knowledge, has antimony been used in the composition of the lead transmitter ?—No; so far as I can see, it is good lead.

Mr. Aston: You asked him whether the plaintiffs' apparatus would act as a transmitter without the diaphragm. Will you ask him whether that is founded upon any experiment, or is it a matter of opinion ?—It is simply from my understanding of the wording and the drawing in the specification.

Mr. Conrad William Cooke, consulting engineer, was called and sworn.

Examined by Mr. Plumptre, he said he had given a number of years' study to electricity, and was a member of the Society of Telegraph Engineers and Electricians and of the Physical Society. He had made himself acquainted with the Edison specification and the Edison transmitter, as well as with the transmitter of the defendant. He was a witness in the Edinburgh telephone action, but not at that tried before Lord Justice Fry. Speaking of a diaphragm in the language understood in connection with telephonic matters, diaphragm and tympan were practically interchangeable terms. He found no diaphragm in the transmitter of the defendants. The function of the diaphragm in all cases in Edison's transmitter was to produce a compression and releasing from compression of the tension regulator. He ought first, perhaps, to have said, to collect the sound waves from the human voice, or rather to vibrate sympathetically under the influence of sonorous vibrations produced by the voice. It was necessary in all instances in the Edison transmitter that there should be direct contact between the diaphragm and the tension regulator or its magnetic equivalent. He was present at the experiments made by Professor Forbes, and corroborated the latter's statements respecting those experiments. He would like to add that, with the putty telephone support, the blocks were firmly embedded in the mass of putty so as to avoid as far as possible their being shaken by the voice, and if shaken at all it would be by the vibrations of the putty, if there were any. There was no looseness of the blocks in the putty.

The Court here adjourned until Friday.

THE INVENTIONS EXHIBITION.

(1308) The Anglo-American Brush Corporation shows some excellent samples of its productions in the shape of dynamos, lamps, and every necessary adjunct of an electric light installation. Its specimens of ship fittings are very satisfactory, both in design and workmanship. A prominent object here is a projector, which is stated to be a great improvement upon any hitherto made. It is capable of being turned in any direction, and of being posed and fixed at any angle to the horizon. The mirror consists of many strips, and any fractured strip can be at once replaced without the least delay. There are two pairs of terminals, one on the stand, and the other on the upper part of the projector, so that in case of damage the cables can be transferred from one to the other. The lamp is of the usual inclined type, working by hand, connection being made by the act of fixing the lamp in place. The carbons are capable of being moved vertically simultaneously, or caused to approach when the arc becomes too long, and the upper carbon can be moved either vertically or horizontally independent of the other, so as to keep the relative positions practically uniform. Other exhibits illustrate the progress made in the construction of the Brush dynamo and in the manufacture of arc and incandescent lamps, holders, switches, carbons, and other accessories.

(1313) Henley's Telegraph Works Company include in its display samples of Henley's patent ozokerited core, a great variety of core and cable for telegraph, telephone, and electric light; Henley's patent wrought and cast iron troughing, for underground conductors; and, as historically interesting, a horse-shoe magnet, capable of lifting 15 cwt., exhibited at the Paris Exhibition, of 1857, and an exploder, made in 1858, used in connection with the blasting operations for the Breakwater, at Portland.

(1314) The exhibit of Callender's Bitumen Telegraph and Waterproof Company consists of single wires, stranded conductors, cables and mains insulated with Callender's patent material, for which the following advantages are claimed over rubber and gutta-percha: it is cheaper and equally effective, it is not melted by heat, is much less inflammable, is thoroughly waterproof, is not deteriorated by exposure to moisture or by changes of temperature, and gives a high insulation resistance.

(1316) The United Telephone Company exhibit a number of both the earlier and the later forms of the Bell Telephone and other apparatus.

(1318) The Consolidated Electric Company, the apparatus employed in the B.T.K. system of electric house-to-house lighting from a central station, as in operation in the town of Colchester.

(1320) The Bernstein Electric Lamp Company, specimens of the Bernstein lamp, the manufacture of which has just been commenced in this country by the company named. The dining-rooms of the present exhibition are lighted by Messrs. Patterson and Cooper with these lamps, which are of 50 C.P. each.

(1322) Electric Apparatus Company, a varied assortment of the most popular articles of an electrical nature, such as gas-lighters, domestic telephones, sewing machine motors, electric light batteries, accumulators, jewellery, lamps, and miscellaneous apparatus for experimental and educational purposes.

(1378) Mr. F. M. Rogers shows, amongst other inventions which he has patented, the following useful arrangements:—1. A fire and frost indicator, consisting of a bi-metallic tongue, which is deflected in opposite directions by the action of heat and cold. The same instrument will give an alarm in case of fire, and, when connected to a special contrivance devised by the maker, will prevent the bursting of water pipes by emptying them when the temperature falls below the point at which the tongue is set to complete the circuit, the trap is equally applicable to intermittent or continuous water supply. 2. An electrical wind vane and indicator, which was devised to supply a want that has often been felt, the usual method of connecting a vane mechanically with an indicator being in many instances impracticable. A small vane attached either to a bracket, or to the ridge piece of a house, is connected to a receiver, which may be placed at any distance from it; upon the dial of the receiver are painted the cardinal and intermediate points of the compass, and when the vane causes the transmitter attached to it to cover any one of the corresponding points a current momentarily flows, and the needle shows upon the receiver dial the position of the vane. No current is wasted except at the moment of sending, and the needle being almost deadbeat responds at once to any alteration. Where a vane already exists the sending portion can be fitted to it, and one sender will supply a number of receivers. One of these receivers connected to a common house battery has been in constant work for over six months, without a hitch of any kind. The arrangement can be worked by simple or multiple wire, and the receiver can, if desired, be made to hang upon a wall, forming a companion instrument to the barometer found in most houses. 3. A railway station indicator, to enable railway passengers to know with certainty the station the train is about to enter, and to avoid the confusion sometimes caused by porters in calling out the names. In each compartment of the carriage is a dial resembling the face of a clock, upon which is painted the names of the stations on the route. A hand, or pointer moves round the dial when a current enters the instrument, the current being sent automatically in the following manner:—Upon the underside of the step board of the first and last carriage composing the train, is pivotted a short arm, which is connected with a battery or some other source of electricity. As the train enters the station this arm strikes against a peg inserted under the edge of the platform, and a current is sent through the indicators, which are arranged in parallel, so causing each pointer to show the station reached.

Telephony in the Colonies.—Experiments in distance telephoning have been recently carried out between Albury, Melbourne, and Sydney. An extra thick wire between the two capital cities was used, and speech between Albury and Melbourne, a distance of 187 miles, was clearly and distinctly heard, the identity of the speaker being easily recognisable.

NOTES.

Electric Lighting in Dye Houses.—Messrs. J. Bannister & Sons, dyers and finishers, Britannia Mills, Leeds, have recently introduced the electric light into their works, and obtained a satisfactory result. The lamps used are the Pilsen arcs of 1,000 candle-power each, and they are run from a Phœnix dynamo made by Messrs. Paterson and Cooper, and the installation was carried out by their representative, Mr. Wilson Woodhead, of Leeds.

Efficient Electric Lighting.—Striking testimony to the efficiency and economy of electric lighting has recently been given, states the *Electrical World*, by the operation of the plant in the *Tribune* building, New York. Mr. Henry Hall, in behalf of the *Tribune*, writes thus to the Consolidated Electric Light Company (using the Sawyer-Man system), after a trial of eight months:—"The plant in this building consists of one 100-light machine, as many lamps as the dynamo will stand, and complete outfit of wiring—the wire, by the way, extending from the cellar and ground floors to the ninth and tenth stories. The lamps give an excellent and satisfactory light, and those in the ninth and tenth stories are as bright as those in the cellar and first story. Their durability is all that can be desired. The dynamo runs without heating, and in a general way the whole plant operates to our satisfaction. The saving in the cost of lighting, as compared with lighting by gas, has been remarkable. The plant has nearly paid for itself in actual number of feet of gas saved in the last eight months, and will soon have paid for itself completely."

The Electric Light for Coal Pits.—The Rev. H. S. Fagan, writes from Great Cressingham, Norfolk, to an evening contemporary, as follows:—"Can any existing form of the electric light be applied to coal pit workings? If not, will coal pit owners stimulate research by offering a reward for an electric light which can be successfully used for the purpose? Christianity, or, rather, humanity apart, *it would pay*; for the total ultimate sum spent in subscriptions, poor-rates, doctors' salaries, and I fear we must add prison expenses (for ruined families are sadly apt to drift into gaol), must surpass that of the costliest electric lighting system. 'Ah! but it's the men's own fault.' Perhaps it is sometimes, though certainly not always; but let anyone lying on his back, with nothing but the glimmer of a closed Davy lamp to help him, trying to pick coal out from between black stones, and he won't wonder that the pitman sometimes opens his lamp so as to get a little more light. With a manageable system of electric lighting accidents ought to be minimised; for then even the danger from matches for lighting men's pipes would be very trifling. At present the miner has the excuse that he must now and then open his lamp; he could never touch the electric burners."

Fire and Electric Lighting.—On Thursday, the 16th inst., a fire broke out at Washington in a building occupied by the offices of several newspapers, and those of an electric light company. Property was destroyed of the value of $150,000. Every lamp connected with the electric light company's office was extinguished, and some portions of the city were left in comparative darkness.

Electric Lighting in Brooklyn.—The contract which the City of Brooklyn made with the electric lighting companies has gone into effect, and by the new arrangement there will be very few gas jets burning in the streets. In the western district of the city there will be 100 electric lights in place of 852 gas jets, and in the eastern district 151 electric lights in place of 955 gas lights. The lights furnished by all these electric lights will equal that of 316,000 candles. The light furnished by the gas jets to be discontinued was equal to that of 44,567 candles.

Electric Lighting at Sydenham.—Some weeks ago we gave a complete description of the electric lighting at Westwood House, Sydenham. On Friday evening last week Mr. and Mrs. Henry Littleton invited a large number of guests to witness some private theatricals, the theatre being lighted throughout, under the direction of Mr. Augustus Littleton, with incandescent electric lamps. The raising and lowering of the luminosity of the lamps was absolutely perfect, and was effected, as we have previously notified, by the approach or retrogression of zinc plates travelling in a trough filled with a solution of sulphate of zinc. The apparatus for this purpose, and the switches for the various circuits, have been designed and constructed in Mr. Littleton's workshop in a manner which would reflect no discredit upon any manufacturer of electrical plant, and the wiring of the theatre throughout has been accomplished by Mr. Littleton personally. This installation at Sydenham is probably as good an example of domestic electric lighting as any now in operation, and we may add that the accumulators used in connection therewith have already exceeded the limit of life given by Mr. F. Geere Howard, without showing any signs of deterioration.

Electric Tower Lighting.—The Brush Electric Light Company is erecting six towers at Indianapolis, at its own expense, and will light from them soon. The towers are from 90 to 130 feet high.

Valuable Testimony.—The State Senate of Pennsylvania has passed a resolution commending the committee on public buildings for zeal in endeavouring to secure the comfort and convenience of the Senate, "and especially so in the introduction of the Edison electric light in this chamber. We find the chamber better lighted, the air less contaminated, and the heat less oppressive."

Electric Lighting in the Colonies.—A preliminary trial of the electric light has been made in the Queensland Parliament buildings, with a fairly satisfactory result.

Electric Lighting Patents in America.—In the United States Court at New Orleans, the Brush Electric Light Company has filed an application for an injunction restraining the Louisiana Electric Light and Power Company from using the automatic magnetic feed for carbons invented by Chas. F. Brush, but which the Louisiana Company is using in lamps purchased from the Jenney Electric Light Company. The application is also for damages for infringements on Brush patents.

Mechanical Telephones.—The following is going the round of our contemporaries: — "Under the designation of 'the mechanical telephone,' a new instrument has just been brought to this country from America, and was tested in London on Saturday. Its construction is simple, and consists of a diaphragm, a sounding-board made of strips of willow wood closely interwoven together and varnished. In the centre of the diaphragm is fixed a disc of metal, from which the communicating wire passes to any point desired up to two miles. The instrument, being enclosed in a small wooden case, can be easily fixed, and remains ready for use, requiring no attention of any sort. Various methods were adopted on Saturday to try the utility of the instrument, and in all cases it fully met the demands made upon it." Surely this must be our old friend the "Empire" telephone, exhibited in London some five months ago, in a new guise?

The Telephone and Thunderstorms.—During the thunderstorms of Tuesday week the electrical disturbance of the atmosphere in Berlin had such an effect upon the telephone system that it was considered necessary to consult the safety of the officials by suspending the service until the storms were over.

Photographing by the Electric Light.—Some experiments took place at Woolwich Arsenal on Saturday last with the view of testing the practicability of photographing the interior of guns by means of the electric light, so as to detect flaws during their manufacture or cracks after firing. Two 8-inch muzzle-loading guns formed the subject of the test. The light was introduced a short distance within the muzzle, and reflected down the bore by means of a mirror, the photograph being taken from the breech end. The light produced by a dynamo was not quite so steady as that from a primary battery of cells, but both gave results.

Telephonic Communication at the Royal Marriage.—In order that direct communication should exist with Her Majesty's royal yachts in Cowes Bay, to enable them to immediately carry out sudden orders from Osborne House, a telephone wire has been recently laid down from the billiard room in the royal residence to the royal landing stage, East Cowes, off which lie at anchor the *Alberta, Victoria and Albert*, and other royal yachts. The telephone was first used on Wednesday morning last, when Her Majesty inspected the Camel Corps, and has been found to work admirably and to be of the greatest possible use. The telephonic appliances consist of Johnson's transmitter and Bell's receiver, which have been supplied by Messrs. Tasker, Sons and Company, of Sheffield.

Telephone Companies.—A Manchester correspondent of a contemporary, dealing with the telephone companies of the United Kingdom, writes:—"The United Telephone Company is the parent company. It owns the patents, and, in conjunction with local promotors in the different districts, has created the other six companies. The names and capital are as follows:—

	Established.	Capital.
United Telephone Company	June 3, 1880 ...	£438,044
Lancashire and Cheshire Telephone Co.	May 31, 1881 ...	296,161
National Telephone Company	Mar. 10, 1881 ...	619,200
Northern District Telephone Company	Dec. 13, 1881 ...	175,000
Telephone Company of Ireland ...	May 27, 1882 ...	190,350
Western Counties Telephone Company	Mar. 24, 1884 ...	400,000
South of England Telephone Company	Dec. 17, 1884 ...	400,000
Total		£2,518,755

Some portions of the preference capital of the above may be still unissued, but even if so it would not materially affect the total. Three months ago there were only 12,730 users of the telephone in the United Kingdom, and it is consequently attempted to earn a dividend on £2,500,000 sterling out of that limited number of persons. Of course the attempt has failed, as some of the above capital pays no dividend, and a portion pays only something trifling. All this capital has not been subscribed by the public; £650,000 of it is in possession of the United Company. It appears as if capital was created and held with the view of a expected sale of the companies to the Government. Notwithstanding all this creation of capital and multiplication of companies, we are to-day, comparatively speaking, without telephones; indeed, the business is so loaded with capital that development is impossible, and we have not in use a tithe of the instruments we shall have within a year or two after the monopoly expires."

Unobserved Cable Operations.—A telegram from St. Petersburgh, published in the *Indépendance Belge*, says:—"The English, after establishing in Quelpaert (at Port Hamilton) a number of coal depots, have raised fortifications, and laid a submarine cable between Quelpaert and an island of the Yang-tse-kiang. It seems that three Russian men-of-war stationed in the waters of Quelpaert did not observe the laying of the cable."

Telegraph Revenue.—The receipts of the telegraph service from April 1st to July 18th, 1885, amounted to £525,000, as against £520,000 received from April 1st to July 19th, 1884.

The Telephone.—The *Standard* is responsible for the following amusing paragraph :—"The improvements in the telephone are reaching such a degree of beautified perfection, that there is some ground for hope the instrument may be improved out of existence shortly. We have always cherished a secret belief that electricity would prove not to be everything in the long run, and human life would once more return to those happier phases it knew before Mr. Edison, or Professor Bell, or any of their ingenious compeers undertook to revolutionise it. That hope may now be expressed in the light of day. A new telephone is discovered, which works indeed through an unhappy and incomprehensible object called a diaphragm ; but upon investigation this horrid name proves to signify a common sounding-board made of strips of willow wood. There is no trace of electricity about it. The strips are closely woven together and varnished. In the midst of them a small disc of metal is set, from which a wire of the most ordinary type proceeds to any point within two miles. It is alleged that 'all demands which could be made' upon a telephone are answered by this simple instrument ; and on Saturday last the assertion was proved true in the presence of a select assemblage. Such valuable communications as the ticking of a watch two miles off were received with enthusiasm and reverence. The proceedings in general were a great success, and electricity, we trust, will be ousted from this field, anyhow. Practical persons were getting tired of it."

The Price of Gas in Ayr.—At their last annual meeting the Ayr Gas Company resolved on advancing the price of their gas from 4s. 7d. to 5s. per 1,000 cubic feet, which is certainly evidence of a very retrograde policy on the part of the directors. As a result of the step now taken by the local gas company, the Town Council have to-day resolved on making a trial with oil as the illuminating agent over a portion of the town ; and there is a probability that the new hotel, which is being built at Ayr Station by the Glasgow and South-Western Railway Company, will be fitted with electric lamps, there being plenty of engine power available upon the establishment. Here is a chance for electric lighting contractors.

The Light given by Glow Lamps.—Herr Peukert's experiments, which we publish in our current columns, are interesting as showing the percentage of the total work of the current in a glow lamp, which appears in the form of light when the lamps are employed under normal conditions, or thereabouts. It is, however, already well known that the light increases in a greater proportion than the heat with increment of current strength, therefore it would have made the results more valuable had the experimenter selected various types of lamps of the same nominal candle-power. It is unfortunate that the Bernstein lamp could not be tested under the same conditions as the rest.

Primary Batteries for Electric Lighting.—Those who believe that economical results may be obtained by using primary batteries for electric lighting, will find sufficient data given in M. Hospitalier's tests with the Bazin elements to enable them to calculate the cost per horse-power hour. Perhaps the resultant figures will somewhat surprise them.

Post-mortem Electrical Experiments.—The *Times* correspondent at Paris, remarks that electrical experiments on the heads of guillotined murderers have been too much the fashion of late. It is satisfactory to find that M. Paul Bert, who has been held up to odium by English anti-vivisectionists, denounces these practices. The distinguished physiologist and Deputy holds that such experiments have no scientific interest, and that they ought to be prohibited. These may, moreover, be made under better conditions on animals. M. Bert's colleagues in the Academy of Medicine coincide in this view.

The Woodhouse and Rawson Lamp.—A correspondent, "An American Engineer," writes as follows to our contemporary *Invention* :—"In your very interesting electric issue of the 11th inst., you speak of the Woodhouse and Rawson incandescent lamp as having now attained a well-merited reputation for excellence. This is hardly borne out by the tests recently applied to these lamps in the United States. This test reached its 1,064th hour on the morning of May 26th. Extraordinary precautions were taken to prevent access to the lamps except by members of the committee in charge of the test. The lamps were lighted on April 11th, and at 35 minutes past 11 on the morning of May 26th the Edison Company, which had entered 21 lamps, had lost 1 ; the United States, which had entered 24, had lost 17 ; the Stanley had lost 19 out of 22, and Woodhouse and Rawson had lost 11, the whole number entered. A lamp which can so easily be snuffed out can hardly be called excellent. If other English lamps are of the same standard of excellence, you will admit that we are somewhat before you in the States in the matter of electric lighting."

The comments of "An American Engineer" are decidedly unfair, and require correction. If Messrs. Woodhouse and Rawson choose to construct lamps taking 4½ watts per candle power, the lifetime of such lamps would be as prolonged as those of Edison. As it is, with lamps requiring but little more than half the energy taken by those of American manufacture to produce a given candle power, the filaments of Messrs. Woodhouse and Rawson manage to attain, in this country at least, a respectable old age. Unfortunately, and this fact is readily admitted by our trans-Atlantic contemporaries, tests carried out by American experts are usually open to criticism, and oftentimes to flat contradiction. In this case no details are yet to hand, therefore it is but right to suspend judgment, but we would suggest that the question of the superiority of this or that lamp or dynamo, should be taken in hand by some of our own technical societies, or by a commission formed of competent and unbiased experts. It is a matter of vital importance that contractors should know where to apply for the most reliable plant, and doubtless firms are to be found willing to assist in meeting the expenses necessarily attached to the carrying out of a long and exhaustive series of tests.

Storms and Electrical Instruments. — A heavy storm broke over Victoria at the beginning of last month, and considerable damage was done. One account states that a thunderbolt fell on Wilson's Promontory, and broke into about a dozen balls of liquid fire directly over the telegraph and telephone wires close to the quarters of the signal master. The wires were fused for a distance of four poles from the battery room into stuff resembling molten lead or solder. The telephone and telegraph instruments were completely broken up. The case enclosing the telephone in the lighthouse porch was smashed into small pieces, and portions were thrown a distance of 15 feet up the tower stairs. The telegraph office instrument table was scorched, other damage to furniture was done, and all the connecting cells were burned completely away. Telegraphic communication with Melbourne was restored next day, new wires being run and the instruments replaced with duplicates.

The Stearns Condenser.—In the United States Circuit Court, New York, on June 26th, a motion for a temporary injunction came on for argument before Judge Wallace in a suit recently begun by the Western Union Telegraph Company against the Baltimore and Ohio Telegraph Company to obtain a decree of injunction against the defendant, prohibiting it from using the duplex system of telegraphy. The particular point in controversy turns on the right of the Baltimore and Ohio Company to use the so-called "Stearns condenser." The motion was to come up again on July 17th.

The Electric Tramway in Blackpool.—On Monday afternoon a series of experimental trips were made over a portion of the Promenade, the car used being one of the very handsome vehicles which have been constructed for the company, and a *fac-simile* of that which is now in use at the Inventions Exhibition, South Kensington. Between three and four o'clock on the day in question, Mr. M. Holroyd Smith decided to have an experimental trip over part of the line. After some little delay, the work of coupling up was accomplished. The electric communication between the generator at the engine-house and the motor under the car, was complete, and all that was wanted was that the rails and centre channel should be cleared of some of the abundant dirt which had accumulated on and about them. This work was at last got through, and some two or three hundred yards of the road made ready for the experimental trip. During the runs, numerous gentlemen—directors, representatives of the press, and others—had seats in the car, and so far as they could judge the running of the car was an undoubted success. Mr. Smith is to be congratulated upon having brought matters to a point of being enabled to make a demonstration. During one of the runs, a railway parcel van was coming down towards South Shore. It had got within twenty feet of the car, which was running at a speed of about six miles an hour, when the horse grew very restive, and backed the van right across the track. Mr. Holroyd Smith, who was driving, turned off the current, applied the breaks, and in less than half its length the conveyance was brought to a dead stand.

Manufacturers and their Employés.—On Saturday last the *employés* of Messrs. Walter T. Glover & Co., the well-known wire coverers of Manchester, to the number of 121, proceeded at early morn to visit Blackpool. Free tickets of admission to the Aquarium and to the Winter Gardens were given to each person; all charges for the railway journey, breakfast, dinner, admission to the Aquarium and Winter Gardens, and the day's wages, were paid by the firm. Mr. Glover did all in his power for the comfort and pleasure of the party, and he hopes to arrange for a similar trip next year. The relations existing between employers and employed are made none the worse for such consideration as this.

Electric Signalling from Balloons.—An invention, which it is hoped will be of importance in future warfare, was on Monday exhibited in the grounds of the Albert Palace by Mr. Eric S. Bruce, the inventor. It consists, as we notified last week, of the application of electric lighting to balloons by means of which signals may be flashed at night over very wide areas. The apparatus consists of an ordinary balloon made of a material as translucent as possible (in the case of the one at present on exhibition the material is cambric) in which are fixed a number of incandescent lamps. The balloon is a captive one, and the rope which secures it is also utilised for conveying the electric current to the lamps inside the balloon. The Morse system of telegraphy is employed for the signalling which illuminates the balloon with flashes of light of longer or shorter duration. We would ask in how far this invention is anticipated by that of Micklewright, described in our columns a few weeks since, or by a system of signalling devised by Mr. Arthur Shippey some three or four years ago.

Electric Rifles.—We observe that a new electric rifle is attracting some attention in the United States on account of its advantages as a military weapon. A primary battery of cylindrical form, 8 inches by 1 inch, is placed in the stock of the gun, and tests have demonstrated that it remains effective up to more than 14,000 rounds; while, as will be readily understood, although a trigger is used for making the electric contact, there is a complete absence of tumbler, hammer, mainspring, and the other rather complicated arrangements of the ordinary lock mechanism.

Kinetic Engineering Company, Limited.—This company is issuing a series of seventeen catalogues, each dealing with a separate department of electric manufactures. The first, "Electric Lighting," contains illustrations and descriptions of a fair assortment of dynamos, arc and incandescent lamps, &c.

City and Guilds of London Technical College.—The students' *conversazione* took place at the College Buildings, Finsbury, on Thursday, last week, the programme comprising an exhibition of machinery, scientific instruments and students' work; a concert; a lantern exhibition by Prof. Silvanus Thompson and Mr. Castell-Evans; a dramatic performance and finally a dance. A large company assembled, and a pleasant evening was spent, thanks to the perfect way in which the arrangements were planned and carried out. The teaching appliances and the drawings, paintings, models, apparatus and instruments executed by students gave a good idea of the thoroughness and practical character of the educational work of the college, and formed in themselves a collection, the inspection of which would well occupy an evening. With such a variety of amusements provided, it was impossible to give everything the attention it deserved, but all passed off to the satisfaction of those whose entertainment was so lavishly provided for.

The Bernstein Lamp.—Dr. Maier informs us that Mr. Alexander Bernstein has taken up his residence in England in order to personally manage the newly organised Bernstein Electric Lamp Company.

The Inventions Exhibition Exhibitors.—We notice that our article on this subject, the first, we believe, in which attention was drawn to certain grievances to which exhibitors are subjected, has had the effect of enlisting the sympathies of some of our contemporaries. One aggrieved individual, who says that "it is an exploded notion that business results from exhibitions, or at least sufficient to pay the expense," but who generally makes a show, from purely scientific reasons we presume, to illustrate the perfection to which some of his inventions have been brought, writes to a contemporary to the effect that an Exhibitors' Association has been formed to effect the following important changes in their present *status*:—1. *To secure united action amongst the exhibitors and their assistants, to remedy grievances, and secure advantages.* 2. *To make exhibitors and their assistants known to each other for recommendation and mutual benefit.* So far as the first clause is concerned we are sorry to learn that exhibitors and their assistants are not united in their action; but perhaps this unfortunate disagreement exists only in the case with which the individual in question is personally connected. The second suggestion seems scarcely feasible: some exhibitors and their assistants might not always appreciate the enforced introduction to the opposition; and, again, what guarantee is there that the benefits to which the writer alludes would be mutual? Such christian-like consideration for the good of others is most rare, and does credit to the breadth of the originator's philanthrophic mind, and to his evident willingness to devote so much of his energy towards securing such a firmly cemented bond of brotherhood. His enthusiasm, however, we think, carries him too far when he asks our good natured contemporary for the use of its offices in which to develop this laudable project.

Electric Launches.—The Electrical Power Storage Company, of 4, Gt. Winchester Street, E.C., is building an electric launch for the Duke of Bedford to be used in connection with his steam yacht the *Northumbria.* The launch will be 28 feet long, and will be suspended from the davits, the accumulators being used in connection with the existing electric lighting of the yacht, when they are not required for propelling the launch.

Gold Extraction by Electrolysis.—A demonstration was given on the afternoon of Friday the 17th inst., to a party of scientific gentlemen, of the process of gold extraction by electrolysis invented and patented by Mr. Henry R. Cassel. This method is shown on a small scale at the Inventions Exhibition, but on Friday, at the works of the Cassel Gold Extracting Company, Limited, in Gray's Inn Road, the process was displayed on a large scale, and explanations given on every point by the inventor and by two gentlemen who have assisted him in the experimental and practical development of the process—Dr. Liepmann and Dr. Atcherley. The process is stated to be purely one of chlorination, and Mr. Cassel has devised means whereby the iron compounds, which are invariably present in refractory ores, are retained in their insoluble form while under treatment, and thus are prevented from exercising any influence upon the solution of gold. This he accomplishes by the addition of caustic lime to the mixture of crushed ore and salt, which earth, by reason of its alkaline properties, at once combines with any free hydrochloric acid as fast as the latter is formed and completely neutralises it, so that no iron can be taken up. At the same time a hypochlorite of lime is formed, which, again being decomposed by the action of the water present, affords additional nascent chlorine for the gold. The apparatus devised by Mr. Cassel for this process is of the simplest construction, and consists mainly of a drum containing the positive electrodes, formed of very dense carbon rods, and a vat containing the negative electrode. Around the circumference of the drum, strong asbestos cloth is arranged for the purpose of preventing the ores from reaching the negative pole, and it consequently acts as a filter. The gold dissolved by the chlorine is carried by the current, as in electro-plating, to the negative pole into the vat, and is deposited there as a black slime, from whence it can be scraped off, and at once melted. The main object of the drum is, that upon revolving the same, the ores inside it are constantly thrown against the positive electrodes, whereby all the particles of gold are brought into most intimate contact with the pole, where the nascent chlorine is generated, and are readily converted into chloride of gold.

Royal Society of Edinburgh.—The concluding ordinary meeting of the society for the session was held on Monday night. Mr. David Milne-Home, LL.D., vice-president, occupied the chair. Professor Tait communicated a paper by Mr. W. Peddie, on a method of determining "The resistances of electrolytes without endeavouring to prevent polarisation."

The Bazin Battery.—Respecting this battery which is described in our columns this week, *Galignani* of the 19th inst. says: "A very interesting *séance* took place on Friday last at the extensive workshops, near Paris, of the well-known mechanical engineer and inventor, Bazin, who, in the opinion of the most competent electricians, has at last succeeded in rendering practically useful electric lighting for domestic purposes. M. Bazin was highly complimented by all who witnessed his practical demonstrations and lucid explanations. Amongst those present we noticed M. Ferdinand de Lesseps; the Hon L. P. Morton, ex-United States Minister to France; M. George Berger, the Director of the Foreign Sections of the Universal Exhibition of 1878, and President of the various International Electrical Exhibitions; Prof. Barker, of the U.S. Commission and Member of the Jury of the Universal Exhibition of 1878; and several Professors of the Ecole Polytechnique.

The Electro-Deposition of Metals.—We understand that Mr. Alexander Watt has been for many months engaged in writing a comprehensive practical treatise on the electro-deposition of metals, including the electrolytic refining of copper and other metals and treatment of ores. The work, being now complete, will shortly be in the hands of the public.

Electric Lighting in Mills.—Messrs. Lister & Co., of Manningham Mills, Bradford, have had running for two years 18 Pilsen arc lamps of 1,000 candle-power each from one dynamo machine. Such satisfaction has been given that this firm contemplates making a considerable extension shortly. The installation was carried out by Mr. Wilson Woodhead, of Leeds, under the supervision of Mr. Thomas Preece, who has had entire charge of all electrical matters in connection with this firm for a considerable time, but who has now received an appointment with Messrs. Paterson and Cooper in connection with Mr. Woodhead, their representative.

Fire Damp.—Colonel J. D. Shakspear gives "a few simple words in plain English" in the *Times* explanatory of "fire damp." He says:—One ton of hewn coal will give off 10,350 cubic feet of carburetted hydrogen—*i.e.*, "marsh gas"—which when mixed with nine times as much air forms 93,150 cubic feet of the most highly explosive "fire damp." We find it exploding on board ship weeks after the coal has been out of the seam, and it might blow up our coal cellars were they air-tight. Also we suspect that coal is under enormous pressure far away in the strata, since a small hole bored into it a distance of only 30 feet produced a "blower" of 460 lbs. or 30 atmospheres on the square inch. Now, if we multiply 10,350 cubic feet, the gas from hewn coal, by 30, we get 310,500 cubic feet as the gas in the strata which may generate and escape per ton into the mine as the pressure is removed, and which on mixing with nine times its volume of air would make 2,794,500 cubic feet of the most highly explosive "fire damp" travelling through the workings, as, forsooth, a ventilating current, in search of a lighted candle or safety lamp, through which it would certainly fire in less than a minute. These figures may startle those who have not educated themselves to their import, but since the year 1878, when carburetted hydrogen was first made liquid, a few, like myself, have learnt to see it at times as a fog developing into "fire damp." My figures are based on the fact that a cubic foot of hewn coal, say 75 lbs., may produce 345 cubic feet of carburetted hydrogen, so any one can verify them. Now, this gas is never found in quantities when atmospheric pressure is on the increase, as shown by a rising barometer; but it is apt to get about in volumes as pressure decreases, as shown by a falling barometer. Well, then, nature is here telling us what to do—viz., deliver air under pressure up to the face of the coal, and so by keeping up the atmospheric pressure stop the coming disaster. But instead of attending to the lesson nature has tried in vain to make us learn, we continue, in open defiance of her teaching, to hurry on a disaster by still more lightening by suction the said pressure, already too light for safety. Having the courage of my convictions, I shall urge, as occasions offer, that ventilation by pressure is the true stay against killing people by hundreds while engaged in their daily occupation. As well expect the Governor of the Bank of England to be well up in gold mining as colliery proprietors to be masters of "fire damp." Nor is it reasonable to imagine the workers of coal to understand more than that it is their most subtle enemy.

The "Great Eastern" Steamship.—In the Chancery Division on Tuesday, before Mr. Justice Chitty, the case of "Marsden *v.* Newton" was resumed. This was an application by the Great Eastern Syndicate, Limited, for the enforcement of a charter party made between the applicants and the Great Eastern Steamship Company, containing a right of hire for 12 months of the *Great Eastern* steamship at £500 per month, and a right of pre-emption during the currency of the charter at the price of £50,000. An order was made that on applicants offering to pay such sum as should be necessary to meet principal, interest, and costs claimed by the debenture holders, the application stand until Monday fortnight, and that no sale in the meantime be directed in the action.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrical Navigation Company, Limited.—Upon terms of an agreement of 3rd inst. (filed on the 14th inst.), this company will purchase the following patent rights of Mr. Anthony Reckenzaun, viz., No. 4764, A.D. 1882, for "electrical apparatus for the propulsion of boats"; No. 5031, A.D. 1883, for "electro-motors," as far as applicable to boats or launches; and No. 6275, A.D. 1884, as applicable to the propulsion of boats. Also provisional protection, No. 3599, A.D. 1885, for "electric motor," as far as applicable to boats; and No. 5376, A.D. 1885, for "improvements in electric boats." The consideration is £1,000 cash and one-third of the shares from time to time issued (fully paid). Out of the cash consideration the vendor is to pay the expenses of the company's promotion and formation. Mr. Reckenzaun is appointed consulting engineer at a salary of £300 per annum.

Blackpool Electric Tramway Company, Limited.—The first return of this company, made up to the 6th ult., was filed on the 16th inst. The nominal capital is £30,000 in £10 shares. 2,850 shares have been taken up, and £5 per share has been called; the calls paid amount to £13,902 leaving £348 unpaid. Registered office, Talbot Square, Blackpool.

LEGAL.

Smethurst and Co. v. Sir Coutts Lindsay and Co., Limited, and Sir Coutts Lindsay, Bart.—A motion was made in this case on Friday last week on behalf of Messrs. Smethurst and Co., lamp manufacturers, 139, New Bond Street, for an injunction to restrain Sir Coutts Lindsay and others, directors of the Grosvenor Gallery, from continuing a nuisance by noise and vibration caused by a steam engine in connection with the electric lighting appliances at the Grosvenor Gallery. The state of things complained of had been going on since last February. The defendant submitted that the nuisance was merely temporary, and that in a few days a new engine would be set up under different conditions, which would remove the cause of complaint. At Mr. Justice Chitty's suggestion an undertaking was given by the defendant to stop the nuisance within a month.

Universal Electric Company.—In the Court of Session, Edinburgh, last week, Mr. Shaw appeared before the First Division, and stated that the liquidators of the Universal Electric Company, the registered office of which is at 4, Baltic Street, Bridgeton, Glasgow, had advertised a note presented to their Lordships asking the Court to sanction compromises, exonerate and discharge liquidators, and dissolve the company. He also stated that the capital of the company was originally £20,000, divided into 400 shares of £5 each; that it was resolved in January, 1883, to wind-up the company; that certain compromises with creditors and contributors had been come to; and that the total amount of the funds realised was £3,028, of which £2,238 had been paid in the discharge of claims, law expenses, and a first dividend at the rate of 3s. 4d. per £—leaving a balance in hand of £830. It is intended to pay a second dividend of 4s. or 5s. per £ to the ordinary creditors—the preferable claims having been paid in full. Their lordships granted the first three branches of the prayer, including sanction of compromises, payment of remuneration, and approval of the liquidators' account.

CITY NOTES, REPORTS, MEETINGS, &c.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited.

Mr. Silver presided on Tuesday, at a half-yearly general meeting of the shareholders of this company, at Cannon Street Hotel, for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend.

Mr. W. J. Tyler, secretary, having read the notice convening the meeting,

The Chairman said: Gentlemen—The object of our meeting has been conveyed to you in the notice. The accounts of the company are, as you are aware, made up but once a year, and therefore I have merely a few general remarks to make. With reference to the sales, I think we may consider that they are up to the average, and I think we may congratulate ourselves. We are certainly indebted to our indefatigable manager and excellent staff for the amount of business we secure. The portion that falls to our lot, I believe, is a fair one, though perhaps our manager will scarcely admit it. I think, whether at home or on the continent, or in the colonies, we are so well represented that we get a fair share of cable sales, and that the returns at the end of the year will show a fair amount. We have in hand a contract for the Indian Government, 500 miles, which we shall complete in the course of a month or two. Of our steamers, one has been employed in laying—re-laying—a cable in the Gulf of Mexico, and another has been chartered by the government for use in the Red Sea. I cannot resume my seat without referring to the increase of capital, which, on the occasion of our last meeting, was suggested and ultimately carried out. The new shares were taken up immediately, and, I need not say the amount has been of a serviceable character to us. I think, therefore, gentlemen, that in these few remarks I am justified in proposing that an interim dividend of 5 per cent., or 10s. per share, free of income-tax, payable after the 22nd inst., be now declared.

Mr. Bannatyne seconded the motion. This interim dividend was, he pointed out, upon both the old and new shares; therefore the dividend was of a larger amount than at the corresponding period of last year.

Mr. Hanson proposed a vote of thanks to the directors, for the way in which they had conducted the business of the company. He had been gratified by the speech of the chairman; although his words were few they were satisfactory. He thought they might look forward with great hope to the annual meeting in November, when he hoped to see good accounts presented.

Sir Wm. F. A. Wallace seconded the proposition. He might add that he was very pleased when the directors asked for more money, because it showed that they thought their business was prospering, and he should be very glad when they asked for some more.

The Chairman thanked the mover and seconder of the proposition, and also other shareholders for their attendancce.

The proceedings then ended.

The Cuba Submarine Telegraph Company, Limited.

THE report of the directors for the half-year ending 30th June is as follows:—

From the balance sheet and accounts it will be seen that the gross receipts (including the tax returned by the Spanish Government and the balance brought from last account) amount to £21,447 0s. 3d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the amount expended on cable repairs) to £6,136 2s., leaving a sum of £15,310 18s. 3d. to the credit of revenue account.

Of this the sum of £3,500 has been added to the reserve fund, increasing that fund to £65,000.

After providing for the preference dividend a balance of £8,810 18s. 3d. remains, out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 10 per cent per annum, free of income tax, which will absorb £8,000, and leave £810 18s. 3d. to be carried forward to the current half-year's account.

The directors have much pleasure in reporting that all the cables have continued in good working order, excepting one of the Santiago Harbour lengths, which underwent some slight repairs in February.

The Globe Telegraph and Trust Company, Limited.

THE report of the directors for the half-year to July 18th, is as follows:—The net revenue of the company for the year, after deduction of expenses, amounts to £182,741 17s. 1d., which, with the balance of £2,088 3s. 4d. brought forward, make a total of £184,830 0s. 5d. From this amount there has been distributed the sum of £130,801 14s. in interim dividends, leaving an available balance of £54,028 6s. 5d. The directors recommend payment of a final dividend for the year of 3s. per share on the preference shares, and of 3s. per share on the ordinary shares (as against 3s. 6d. last year), making, with the former distributions, a total dividend for the year of 6 per cent. upon the preference and 4½ per cent. upon the ordinary shares, carrying forward a balance of £1,791 15s. 5d. The reduction of the tariff of the Atlantic Cable Companies, on the opening of the Commercial Company's (Mackay-Bennett) Cables, has led to a diminution of this company's revenue, and a consequent reduction of the final dividend upon the ordinary shares. Forty-eight of the shares of the German-Norwegian Company have been drawn and paid off at par, and the proceeds carried to the credit of the capital account. In all other respects the company's investments remain same as in last year's accounts.

Anglo-American Telegraph Company, Limited.

THE report of the directors for the half-year states that the total receipts from the 1st January to the 30th June, 1885, including a balance of £1,676 14s. 8d. brought forward from the last account, amount to £142,256 19s. 4d. The traffic receipts show a decrease as compared with the corresponding period of last year of £92,730 consequent upon competition, and reduced tariff, and continued depression of trade between Europe and America.

The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £51,913 13s. 9d.

The directors, under the powers conferred upon them hy the Articles of Association, have, before declaring the net profits, set apart the sum of £50,000 to the renewal fund, leaving a balance of £40,343 5s. 7d.

One quarterly interim dividend of 4s. per cent. on the ordinary stock, and of 8s. per cent. on the preferred stock, was paid on the 1st May, 1885, absorbing £14,000, and a second quarterly dividend of 6s. per cent. on the ordinary stock, and 12s. per cent. on the prefered stock, will be paid on the 1st August, 1885, absorbing £21,000, leaving a balance of £5,343 5s. 7d. to be carried forward to the next account.

The company's repairing ss. *Minia* has been engaged during the past half-year in the repair of the main cable of the Direct United States Cable Company and the main cable of the Paris and New York Telegraph Company. She is now at work upon the repair of the Western Union Telegraph Company's cable (broken off the Great Bank of Newfoundland), having been chartered to that company for the purpose. The *Minia* has also restored communication upon the Brest-St. Pierre cable, laid in 1869, which was broken at 240 miles from the French coast.

The company's four main cables are in good working order, but the Duxbury Cable, Northern Placentia, and Island Cove cables are all broken in shallow water. The interruption of communication upon those cables, however, does not interfere with the prompt transmission of the traffic, as alternative routes exist.

The stockholders will have seen from the official reports circulated by the company, of the proceedings at recent half-yearly general meetings, that the directors have been severely criticised and strenuously opposed on account of the policy adopted by them some years ago (with the full knowledge and sanction of the stockholders), of placing an annual contribution of £150,000 to the credit of the renewal fund, in order to provide for the replacement of the cables as and when they are worn out.

In order to absolve the directors from the charge of having needlessly deprived the stockholders of dividends fairly and honestly earned, it has been thought desirable to explain the reasons which have induced the board to adopt a policy which has latterly met with so much opposition.

Without any technical knowledge of submarine cables, it must be obvious to all that from the hour of submersion they are subject to special depreciation, and consequently that the duty of the directors of such undertakings is to ascertain, as far as practicable, the number of years the cables are likely to last, and to make reasonable provision for their renewal.

For many years previous to the amalgamation in 1873, the position of the various companies was so uncertain, and the experience of submarine cables so limited, that the accumulation of a renewal fund upon any fixed principle was impossible, and it was not until after that date that the present system was commenced, and consequently, in order to make up for lost time, a much larger annual sum has hitherto been necessary than would have been required had the accumulation commenced from the date the cables were submerged.

The amount which appears to the credit of renewal fund in the present half-year's accounts is £788,331 18s. 3d., and the directors, having again carefully considered the matter, have come to the conclusion that unless some extensive replacement of cables becomes necessary in the meantime the contribution from revenue to that fund during the current year and the two following years may be taken at £100,000 instead of £150,000 as heretofore, and they trust that after the expiration of that period a still further reduction may be made.

The proposition made at the last general meeting by one of the proprietors that the interest of the fund should be paid by way of dividend, cannot be adopted, as the amount set aside in each year has been based upon the principle of a sinking fund, which necessarily includes compound interest.

The reduction of tariff to 1s. 8d. per word, commenced on the 24th December, 1884, in consequence of the opening of the Commercial Cable Company, still continues in force; the result is that none of the companies engaged in carrying telegraph traffic across the Atlantic are earning any substantial dividend.

The Submarine Telegraph Company, Limited.—The accounts for the half year ending June 30th show a balance, subject to audit, which enables the directors, after adding 15 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 15 per cent. per annum.

Consolidated Telephone Construction and Maintenance Company, Limited.—The shares of this company are to be quoted on the Stock Exchange as of a nominal value of 15s. instead of £1 each.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th July, are £2,529, as compared with £3,141 in the corresponding period of 1884.

NEW PATENTS—1885.

8566. "Dynamo-electric machines for preventing sparking." T. J. HANDFORD. (Communicated by R. H. Mather.) Dated July 15. (*Complete.*)

8568. "Dynamo-electric machines for supporting the armatures of such machines." T. J. HANDFORD. (Communicated by R. H. Mather.) Dated July 15. (*Complete.*)

8574. "Treating metals, alloys and auriferous ores by electrolysis." H. R. CASSEL. Dated July 15.

8588. "Electrodes for secondary batteries." N. E. REYNIER, A. SIMMEN. Dated July 15.

8613. "Method of 'parcel' or partial electro-gilding metallic articles." J. M. DAVIS. Dated July 16.

8621. "Electrical signalling or alarm apparatus for railway and other purposes." W. R. LAKE. (Communicated by M. W. and M. F. PARRISH.) Dated July 16. (*Complete.*)

8622. "Electrical communications between door knockers, letter boxes and bells." R. A. LEE. Dated July 16.

8627. "Galvanic batteries and the electrodes of electrolytic converting tanks or troughs." W. H. TASKER, S. J. JONES. Dated July 16.

8631. "Apparatus for indicating the presence of fire-damp in mines." W. R. LAKE. (Communicated by J. Kitsee.) Dated July 16.)

8661. "Refining copper, &c., mattes by electrolytic and chemical actions." W. WOOD, M. H. HURRELL. Dated July 17. (*Complete.*)

8675. "Telephonic apparatus." W. BLENHEIM. Dated July 18.

8684. "Circular magnetic looms." E. WINCKLER, J. J. HEILMANN. Dated July 18.

8703. "Device for straining and fastening guy ropes or wire stays of telegraph posts." D. SINCLAIR. Dated July 18.

8704. "Wire coils for electro-magnets." H. ARON. Dated July 18.

8706. "Machinery for covering wire for telegraphic, telephonic and other electric and like purposes and methods employed therein." J. C. [illegible]ARS. Dated July 18.

8712. "Apparatus chiefly designed for facilitating the carriage or transfer of money and small parcels from one part of a building to another." H H. LAKE. (Communicated by D. H. Rice.) Dated July 18. (*Complete.*)

8727. "Construction and application of electric incandescent lamps." P. M. JUSTICE. (Communicated by I. W. Heysinger and J. Pusey.) Dated July 20. (*Complete.*)

8731. "Apparatus for generating or storing electricity." J. NOAD. Dated July 20.

8733. "Galvanic batteries." W. H. QUARTERMAN. Dated July 20.

8743. "Combination of telephonic apparatus and electric bells." J. H. JOHNSON. (Communicated by P. Barbier et Cie.) Dated July 20.

8744. "Apparatus or means for controlling the passage of electric currents in telephonic or other electric circuits." J. H. JOHNSON. (Communicated by P. Barbier et Cie.) Dated July 20.

8747. "Machines for generating electromotive power." A. I. GRAVIER. Dated July 20.

8751. "Construction and adaptation of electric lamps to the lighting of mines, coal bunkers, holds of ships, and analogous purposes." O. C. D. ROSS. Dated July 20.

8758. "Telephonic connections." A. C. WELLS. Dated July 21.

8775. "Microphones." W. P. THOMPSON. (Communicated by K. S. Dembinski.) Dated July 21.

8777. "Method of neutralising inductive disturbances in telephone circuits and apparatus therefor." W. P. THOMPSON. (Communicated by W. A. Jackson and J. C. Chambers.) Dated July 21. (*Complete.*)

8782. "Telephonic transmitters and parts of the same." R. H. RIDOUT. Dated July 21.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

2685. "Self locking electrical testing key." B. PELL. Dated February 27. 4d. Relates to a construction of testing key in conjunction with a spring latch, which, when the key is depressed, automatically catches and holds it with certainty in position until it is released, the movement either in depressing the key or in releasing it being effected by one hand.

3851. "Improvements in and connected with telephones." P. M. JUSTICE. (Communicated from abroad by F. Blake, of America.) Dated March 25. 6d. Relates to that class of telephone transmitters in which a powdered or granulated conducting material forms that portion of the telephone circuit the resistance of which is varied under the action of sound waves. In figs. 1 and 2, A is the bed or support for the telephone, and contains the aperture through which speech is uttered; B is a ring of non-conducting material resting on the bed, A, and *b* is a metallic ring resting on the bed, A, within the ring, B, and forming the seat of the diaphragm. In one form of construction, the rings, B and *b*, are both of non-conducting material, and are formed in one piece; the bed, A, in such case being omitted. D is a metallic diaphragm resting at its edges upon the ring or seat, *b*. The diaphragm, as above stated, is one of the electrodes, and in practice it is connected with one of the circuit wires through the seat, *b*, when that seat is metallic, or directly with such wires when the seat, *b*, is integral with the ring, B, and is of non-conducting material. S is a wire sieve, electrically separated from the diaphragm by a washer of non-conducting material. P is a metallic clamping plate having a boss or ring projection, *p*, that rests upon the sieve at the edge of the latter. The plate, P, and the ring, B, have the same diameter; and so likewise the boss of the plate, P, the sieve, S, the washer, *w*, the diaphragm, D, and the seat, *b*, are equal in diameter; and accordingly the different parts of the instrument are held together by screws passing through the plate, P, and the ring, B, and into the bed, A, when a bed is employed. Electrical connection is made between the sieve-electrode, S, and its circuit wire through the metallic clamping plate, P. C is a finely divided or granulated carbon filling the instrument above the diaphragm to within a short distance of the plate, P. The grains are of a size that permits them to pass freely through the sieve, which is buried in their mass. The plate, P, has a hole through which the granulated conductor is poured. This hole is closed by a screw plug, E. L is a post or block of non-conducting material inserted between the diaphragm and the sieve, thereby straining the diaphragm. It also gives to both the diaphragm and the sieve a conical form; and, being firmly clasped between the diaphragm and the sieve, as between two springs, causes the latter mechanically to partake of the vibrations of the former. When the instrument is connected up for use, as before stated, one wire leads to the diaphragm and the other to the sieve. The diaphragm and the sieve thus become electrodes, the granulated conductor making the electrical connection between them.

FIG. 1.

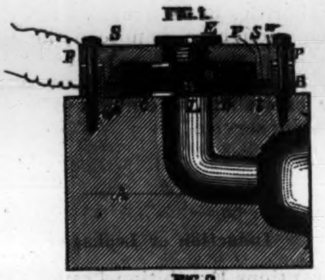
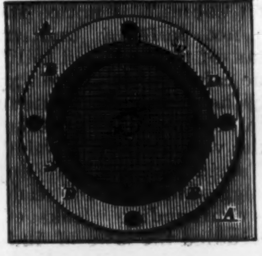


FIG. 2.



3944. "Improvements in galvanic batteries." W. J. S. BARBER-STARKEY. Dated March 27. 6d. Relates to that class of electrical generators known as galvanic batteries, and which depend for their operation upon chemical action. It is designed to produce a battery cell, which, whilst capable of developing a steady, continuous and powerful electromotive force, as a primary generator, shall, at the same time, be capable of regeneration in a very perfect manner and to a practical extent, by the reversal of a current through it from an external source, in the usual way, as a secondary battery or accumulator. The elements employed are as follows:—The exciting fluid consists of bi-sulphate of mercury in a solution of sulphuric acid, variable according to the purposes for which the battery is required, and which acid is found to be necessary to produce the powerful, constant and regenerative action of the improved battery. For telegraphic purposes the inventor prefers to use a weak solution of sulphuric acid, of about 1 in 24. For lighting purposes, however, the strength of this solution may be increased up to about 1 in 8, according to requirements. The electrodes are respectively carbon or lead, conveniently formed as a rod or rods, or plates, in combination with a large quantity of broken carbon constituting the one electrode; and zinc, or zinc and lead combined and amalgamated.

3967. "Improvements in or relating to switches or electrical current changers." J. MACKENZIE. Dated Maich 28. 4d. The object of the improvements is to provide a durable, effective and cheap instrument, combining very simple mechanism, which shall be applicable to any electric circuits for the purpose of establishing good electric contacts, between any one conductor and any other conductor or conductors, or for shunting an electric current from one circuit to any other circuit or circuits connected with the switch, and to change the contact instantaneously when required from one to another.

3968. "Improvements in and relating to apparatus for opening and closing electric circuits." J. MACKENZIE. Dated March 28. 4d. The object of this invention is to provide a neat, effective, and cheap instrument, applicable to all electric circuits, for the purposes of making or breaking such circuits instantaneously, and without risk of the switch being left, as is often the case, partly "on" and partly "off."

3969. "Improvements in fusible connections for electric circuits." J. MACKENZIE. Dated March 28. 4d. Relates to certain improvements in fusible connections for electric circuits, the object being to provide a compact, reliable, and inexpensive instrument, by which an electric circuit will be broken, when the wires or cables are overcharged with excessive electrical currents, and readily closed by hand when the current is returned to its normal strength, without the necessity of providing fresh and separate safety fusible connections.

CORRESPONDENCE.

Meardi's Amperemeter.

Above all things, accept my most profound thanks for the publication of the account of my ampèremeter in your esteemed journal. In your last issue (July 18th, 1885) I find a note in which it is said that a similar apparatus had been previously devised by Mr. Millar, of the Gérard Company. Before publishing the description of my apparatus in the *Giorno*, I consulted the index of patents obtained by foreigners in Italy, from 1881 forwards, as well as the most recent publications, and I have not found the announcement of the apparatus of Mr. Millar, nor yet in a catalogue of apparatus for electric lighting issued by the said Gérard Company. I must therefore beg you to accept my declaration that the said Millar's ampèremeter was absolutely unknown to me before yesterday.

Further, from April 20th of the past year, 1884, I have published in the *Giorno* certain proposals for utilising, as an antagonistic action to that exerted by the polarising action of a solenoid, the greater or smaller counterpressure resulting from a greater or smaller removal of mercury effected in the core itself. I do not know whether this proposal precedes the invention of Mr. Millar or not.

The main object which I wished to combine with my voltmeter is to obtain in a simpler and more economical manner than has been effected by others, is the acoustic signal when, in an industrial installation of the electric light, the electromotive force exceeds a given limit with grave detriment to the duration of the lamp. I venture to hope that this fundamental speciality of my apparatus, characterised by the simple and economical manner in which I believe I have solved the problem, will entitle me to the exclusive priority of invention; a difficult thing to-day by reason of the feverish activity with which many are simultaneously impelled to the solution of new and identical problems.

P. Meardi.

Turin, *July 19th*, 1885.

Electric Bells.

It is rather surprising to see how such a simple fact as "placing electric bells in series" can be called by one of your correspondents a "question of the day."

If you simply place all the coils in series, of 100 bells if you like, leaving but one of the beaters in the circuit, all the bells will be synchronised and ring at the same time. Don't you call that very simple?

E. Duchamps, C.E.

London, *July 20th*, 1885.

Distribution of Electrical Energy.

In your notice under the heading of "Distribution of Electrical Energy," you remark as follows :—

"It is evident, however, that the loss in transformation must be much higher than that occasioned in the method adopted by Gaulard and Gibbs ; and in addition to this, the scheme has been before proposed, if not actually carried out to a practical issue."

Upon what, Sir, you base your evident opinion we are at present quite in the dark, and think you might have waited till such proof as an independent unbiased witness can give before making this misleading remark. Secondly, it seems to us most extraordinary reasoning, that because you assert others have thought of this mode of distribution it should be useless and not worth considering. We shall be glad if you will allow space for these few remarks in your journal, and to reserve your criticism upon our system till such time as you will have had an opportunity of closely investigating the same. This opportunity we gladly offer to you or any of your readers.

Paris & Scott.

July 21st, 1885.

[We base our opinion on the description of the apparatus as given by our correspondents themselves. Their transformer has an armature wound for high tension and low tension, and two commutators. The high tension portion drives the armature, the low tension side giving off the lighting current. Now this means that if from a generator we produce an initial source of electrical energy and convey a current to the transformer, this then resolves itself into a motor which, in its turn, generates a current in the second coiling of the armature for practical application. Messrs. Paris and Scott probably know what percentage of return is obtained in the transmission of power by means of electro-motors ; at all events—leaving alone the second loss in reconversion—they know it does not reach the 96 per cent. obtained by Prof. Ferraris with the Gaulard-Gibbs secondary generators.—EDS. ELEC. REV.].

Cheap Telephony.

I see in your issue of the 11th inst. a notice upon "Cheap Telephony in Sweden," where it is said that the charge for a subscriber belonging to the Mutual Association at Gothenburg is only £2 15s. per annum. This statement seems to be calculated to convey a wrong impression, for why is there no mention made of the cost of the line construction and the instruments being at the charge of subscribers with this association, in contradistinction to the Bell Company, which, at the rate of £4 10s. per annum, undertakes the construction of the line and placing of instruments without any extra charge. This system of mutual association has, I venture to say, no future, the cheapness aimed at being its germ of death. With same, you cannot compel subscribers to take improved instruments later on, if they won't pay for them, and in course of time there would be different styles of instruments, to the detriment of the uniformity and goodness of the service. This system means economy at any price : cheap instruments, cheap material, and underpaid staff, &c. ; it means the impossibility of making experiments, of introducing new, oftentimes very costly, installations in the central offices and the nets, and even, as time will prove, of properly maintaining the old installations. In short, the clear result will be after some time, a bad service tending to disorganisation and to the discredit of the telephone in general. A first class service is the principal condition of life for telephone exchanges. That the association at Gothenburg will, in length of time, be unable to even defray its expenses, there can be no doubt about that, for the Bell Company, notwithstanding its higher rate, has been unable to pay dividends. With a responsible company the aspect of things is quite different ; in order to make progress, it is obliged to satisfy the public and to keep the service on the height of times ; this involves the necessity of having a sufficient and competent staff, of taking the best instruments and materials, in general, of introducing the latest progress. All these good things cannot be had at starving rates. The Gothenburg Bell Company, which formerly used the Gilliland switch boards, has recently installed the multiple system. Such changes of a costly nature cannot, and will certainly not, be made by mutual associations based on cheap rates.

If cheapness is to be the only desideratum, the telephone, which is still in its infancy, can neither prosper nor progress—without prosperity no progress ; and no prosperity without adequate remuneration ! The extensive development of the telephone in America is intimately connected with the protection the industry enjoys there, along with public support. Governments and town authorities have in many countries of Europe already done enough to handicap the telephone ; it only needs still a steeple chase for cheap rates, *coûte qu'il coûte*, to kill the whole industry, a warning example for capitalists to embark money into enterprises for public service !

N.

Induction or Leakage ?

At the Inventions Exhibition I came across a circular entitled "Belt Cables." I notice therein a paragraph which I do not perfectly understand. The writer suggests a plan of laying "lead foil" along the length of "telephone cables which have a plain or corrugated surface," thus, he explains, minimising the confusion of messages by induction. He goes on to say, "We use material of the very highest insulation, but this plan covers any accidental use of imperfect material." Does it not suggest itself in the reader's mind that this gentleman is confounding "leakage" with induction ? as if he had studied the laws of induction I think he would find that the more he insulates his wires (in reason) the more induction he will get ; this accounts for the well known fact among telephonists that little, if any, induction is experienced on an "earthy" wire, where an earth wire is used in place of a metallic circuit.

W. J. Sandy.

July 18th.

Hedges's Steam Gauge.

My attention has been called to a paragraph in your issue of the 11th, in which you state that "a precisely similar arrangement to that of Mr. Killingworth Hedges's was devised and tried more than a year ago by Mr. Sweetser, who abandoned the idea as not being commercially successful." Although I had not previously heard of this gentleman's invention, I am fully aware that the employment of a rotated column of liquid is not new ; in fact, the principle was described by Dr. Lardner in one of his earliest treatises, and it is with full knowledge of the failure of many inventors to make such an instrument a commercial success that I have devised the plan which you have been good enough to illustrate. Acting under the advice of my patent agents, Messrs. Abel and Imray, I have obtained a patent for certain novel details and improvements, which will enable my manufacturers to construct an accurate speed gauge, and sell the same at a far lower price than those at present in the market. The instrument has been tried not only on locomotives, but also on board ship, and has given equally good results.

Killingworth Hedges.

P.S.—I should be extremely obliged if Mr. Sweetser and others would send me particulars of speed indicators having historic interest.

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